BULLETIN

OF THE

DEPARTMENT OF AGRICULTURE, JAMAICA

EDITED BY

WILLIAM FAWCETT, B.Sc., (LOND.) F.L.S.

Director of Public Gardens and Plantations.

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HOPE GARDENS, JAMAICA:

1908.

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Hope Gardens, Kingston P.O., Jamaica,

10th July, 1908.

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A Copy will be supplied free to any Resident in Jamaica, who will send name and address to the Director of Public Gardens and Plantations, Kingston P.O.

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GRAPE VINE CULTURE.

Compiled by W. HARRIS, F.L.S., Superintendent of Hope Gardens

CONTENTS.

Information on Grape Vines appears from time to time in the Bulletin between the years 1887 and 1905. As this information is scattered over a period of eighteen years it has been considered desirable to arrange it under proper headings and issue it in pamphlet form for the convenience of grape growers.

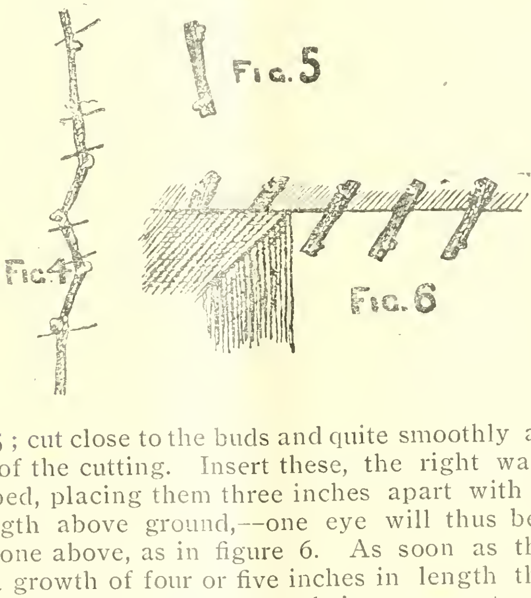
The articles and notes were contributed mainly by Mr. W. Cradwick, Travelling Instructor, Mr. W. J. Thompson, Superintendent of King's House Gardens, and the Rev. Wm. Griffith of Kingston, all of whom are experienced and successful growers and have devoted much time and study to the cultivation of this fruit which has attracted the attention of man from the earliest time; indeed, records of the cultivation of the grape, and of the making of wine in Egypt, go back 5000 to 6000 years.

The Grape Vine (Vitis vinifera), is found growing wild in the temperate regions of Western Asia, Southern Europe, and parts of Northern Africa, and is generally believed to be a native of that part of Asia Minor to the south of the Caucasus and of the Caspian Sea. According to De Candolle in "L'Origine des Plantes Cultivees," it grows there "with the luxuriant wildness of a tropical creeper, clinging to tall trees and producing abundant fruit without pruning or cultivation."

Where the information already published in the Bulletin is not sufficiently explicit or complete it has been supplemented, in the following notes, from other sources which are duly acknowledged.

PROPAGATION.

Mr. Cradwick writes—"The wood that is cut from the vine, when pruning, can be used for propagating. To propagate young plants, take the canes which have been cut off, select all the wood which is not thinner than one's little finger and cut this up into lengths as shown in figure 4. This will give cuttings of two joints



as in figure 5; cut close to the buds and quite smoothly at both top and bottom of the cutting. Insert these, the right way up, into a prepared bed, placing them three inches apart with two-thirds of their length above ground,—one eye will thus be under the ground and one above, as in figure 6. As soon as the cuttings have made a growth of four or five inches in length they should be lifted and potted, or planted into their permanent positions."

The Rev. Mr. Griffith writes—"Vines are raised in a variety of ways, from seeds, layers, single buds, and from cuttings taken from healthy, fruitful vines. These should be obtained from stout, well ripened canes of the present year, the stouter and the more close-jointed the better.

"The almost universal custom in England is to propagate from single eyes. The custom with us is to grow from cuttings with two to four buds, the fewer eyes the better. My method is to use cuttings with two buds planted firmly in light soil so deeply that the upper ends just peep above the surface of the soil; the bottom bud remains dormant and on the cut surface, just under it, the callous is formed from which the roots proceed. All buds, without exception, are produced on the node or joint of the cane, but roots grow from any part, nodes and internodes alike. By the time the cutting has made three or four leaves it will have exhausted its stored-up reserve of food and must depend upon the new rootlets for further supplies. If a little good soil is drawn around the base of the bud from which the new growth proceeds, a number of new roots will appear at the base of the green shoot, and when the young plant is transferred to the quarters where it is to remain permanently, the lower portion of the parent cane may be cut away and we thus secure a young vine which is practically a plant from the bud. The severed portion on which are the first formed rootlets, and the bottom dormant bud may also be planted and, as a general rule, will furnish a stout, healthy vine."

Mr. A. F. Barron says*—"Vines are propagated by cuttings in the vineyards of all the great vine-growing countries, where plants are required by thousands. The cuttings are selected and cut into lengths of from eight to twelve inches, leaving usually attached a small piece of the two-year-old wood,—a "heel" as it is termed. The lower eyes or buds are cut out leaving only two or three at the top of the cutting. In the vineyards these cuttings are planted in the ground at once, in small trenches, and treated as permanent plants."

Grafting Grape Vines—During the year 1901-02 experiments were carried out in grafting cultivated grape vines on stocks of the native wild grape (*Vitis caribaea*) but this was not found to answer.

Old plants of the wild grape may be seen in limestone districts with main stems of a considerable thickness, but these must be of a great age. Usually the wild grape has slender stems, and by actual experiment it was found that these are not nearly so vigorous in growth as stems of cultivated varieties, both being grown under similar conditions, therefore the plant is not suitable as a stock plant for grafts of cultivated varieties of *Vitis vinifera*.

SITE FOR VINERY.

Mr. W. J. Thompson writes—"The vines must be planted so as to be exposed to the morning sun; if they can have sun shining on them all day, so much the better; but vines must have sun from early morning to past mid-day to do any good."

Mr. Cradwick writes—"The first indispensable qualification for the site of the vinery is that it should be where the vines will receive all the sunlight possible; the next is that it should be in such a position that the roots of trees should not penetrate the border and so rob the vines of the store of plant food provided for their use."

Mr. Griffith writes—"The selection of a site for either a vine or a vineyard is a matter of some importance. In towns, as a rule, there is little room for choice in the matter. It is indispensable, however, that sunlight and plenty of air should be secured.

"The grape vine succeeds well in low lying situations not much

* In Vines and Vine Culture.

above sea-level, and best near the sea. A common opinion, for which there must be some ground, is that the vine never does well on high ground in the interior. In England most, if not all, the great grape growing establishments are little above sea-level. The probable reason may be the more even temperature as between day and night that prevails on the low lands as compared with the hills. During the twelve months of the year the vines can bear very wide divergences of temperature, but a difference of 10° to 15° is all that they can endure with safety as between noon and night. There is also a considerable difference in the adaptability of varieties for special localities."

Mr. Cradwick writes—"My present opinion is, and in this I am borne out by that eminent grape grower, the Rev. W. Griffith, that the hot lowlands near the sea are the places peculiarly adapted for grape growing, and that the elevation of Hope, 600-700 feet, is much against it."

PREPARATION OF THE BORDER.

Mr. Cradwick writes as follows:—"Dig out a trench four feet wide, and two and a half feet deep, the length to be regulated by the number of vines to be planted. In digging out the trench be careful to separate the good top soil from the subsoil if the latter be clay, sand or any such material which contains no plant food. When the trench has been dug to the required depth return the good top soil to the bottom of the trench; place on the top of this, if possible, a layer of good rotten cow manure six inches deep; to this may be added charcoal, wood-ashes, bones, and spent lime, forming a layer two inches thick: fill up the trench with good ordinary soil and give the whole a soaking of water, allowing two or three days to pass before planting.

"Vines must be planted in an open situation at least one hundred feet from any large tree, and the border should have a southern or south-eastern aspect, quite free from shade as the early morning sun is indispensable."

The Rev. Mr. Griffith writes:—"Before the vine is planted the soil should be well broken up to the depth of eighteen to twenty-four inches. The deeper and broader the tillage, the larger the root run, the ampler will be the food supply and the more vigorous your vine. Some well rotted stable manure, wood ashes, broken bones and lime rubbish added at the time the ground is prepared will be of lasting service."

Mr. W. J. Thompson writes:—"To give the vine a good start a pit six feet square and eighteen inches deep should be dug. If the soil is of a stiff nature add one-fifth sand, one-fifth burnt rubbish and a cart-load of short stable manure, mixing the whole up thoroughly, watering the mixture if dry, then filling up the pit with it, and allowing it to settle for a week before planting. It is not advisable to plant vines in ground that has not been dug or trenched to a depth of eighteen inches."

PLANTING YOUNG VINES.

Mr. W. J. Thompson writes:—"Vines can be planted at any time of the year, but they will do much better if planted before May as they will then get more light and warmer nights than if planted at the end of the year. In planting, care must be taken that the roots are laid out straight from the centre, also that the base of the new growth just touches the soil, so that roots can form from this part. As soon as the vines are planted the ground should have a copious supply of water to wash the soil well in between the roots. After the first watering, if done thoroughly, the plants will not need watering again for about fourteen days, but from then until the end of September, by which time they should have made good growth, they should never be allowed to suffer for want of water. From September to January they should be kept without water to allow the canes to ripen. When the young plants are put out a strong stick should be fixed near each for the vines to climb on."

Mr. Cradwick writes:—"In planting out a young vine be sure it is very wet at the roots before you attempt to remove it from the bamboo pot. Do not attempt to shake it out of the bamboo pot but take a cutlass and split the bamboo from bottom to top on both sides so that the young plant lies in one half of the bamboo. Make a hole in the border with the hand, of sufficient size to receive the roots of the young plant easily; the roots should be carefully spread out, covered with soil which should be pressed only a little with the hands, and then well-watered. The action of the water will cause the soil to settle down round the young plant. In putting out any young plants it is necessary to be careful not to make the soil too tight, for if pressed down too firmly it hinders the freedom of root action without which satisfactory growth cannot be made. For the first year a good strong, straight stick is all that is needed in the way of arbour."

The Rev. Mr. Griffith writes:—"Having everything in readiness when you plant your young vine, let the surface of the soil for from twelve to eighteen inches round it be about three to four inches below the surface of the surrounding ground; let the collar of the vine, i.e., where the junction of the new growth is made with the old wood, be just beneath the surface of the soil. As the vine makes growth this slight depression will come in useful both as a convenience for mulching and watering, as well as keeping the new roots at home. Little by little, about an inch at a time, the soil can be raised round the vine until it is level with the surrounding surface. Into this new soil the vine will send out a multitude of rootlets, and the old wood, from which the shoot originally grew, will gradually perish, and you will get what is practically a vine from a bud, which is the very best possible.

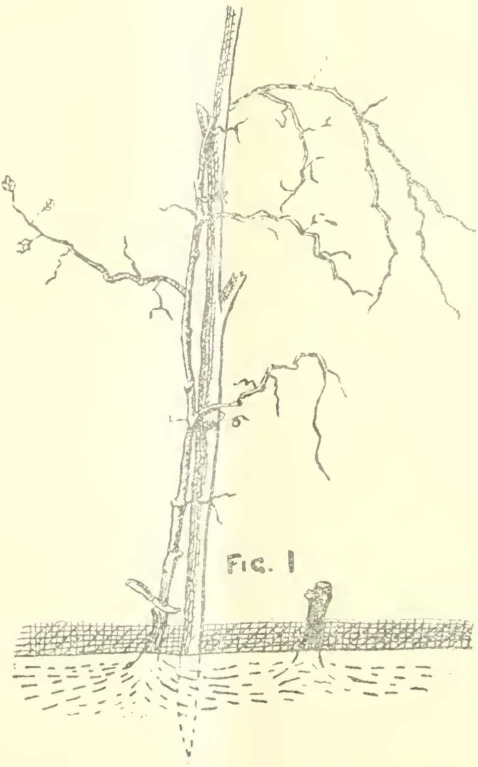
So soon as root action begins and new growth shows, a stout, straight stick, six to eight feet long, should be given it to climb up. Without this artificial aid the vine will show possibly two or three growths, not one of them of any value, and it will sprawl all over the ground. On whatever side you insert the stick, the vine will find it, lay hold upon it, and will not be long in finding its way to the top."

Distance apart at which to plant.—Mr. Cradwick says:—"The first vine should be planted two and a half feet from the end of the border, and a space of four or five feet should be left between every successive vine."

Mr. A. F. Barron says:—"This depends to a great extent on the style or mode of training to be adopted. For permanent vines the distance of five feet is not at all too much, although frequently they are planted much closer. If we here consider the rods or stems as separate plants we must then allow space between the stems for the proper development or extension of the side or bearing shoots, and as these extend from two to two feet six inches on either side, it follows that a space of from four to five feet is required."

PRUNING AND TRAINING.

Mr. Cradwick writes:—"The young vines planted out last year should be pruned during the last week in February or first week in March. This should be done by cutting the plants down to the strongest eye which is generally the lowest and about three inches from the surface of the ground as in figure 1.



When the vine commences to sprout again only the strongest shoot should be allowed to grow to form the permanent vine; all small shoots must be cut off, see figure 2. This shoot must be kept

FIG. 2

trained straight or if the vine gets inconveniently long, it should be very gradually turned, as a sharp bend in the vine will check the flow of sap beyond the bend and over-feed one part of the plant to the detriment of the other. As the vine grows it throws out side branches which should have the points pinched out as soon as they have made two or three leaves as shown in figure 3,

FIG. 3

and as they shoot out afresh the points should be again removed. But on no account allow the point of the main growth to be touched or interfered with in any way. Try to make the vine grow as long as possible; it will get stout of its own accord. Cover the roots with rotten cow manure a foot thick if possible. Two weeks after pruning a thorough soaking of water must be given, and this should be repeated every fortnight up to the end of August, provided that it is not done naturally by rain."

We will assume that the vine has now completed its second year of growth from the original cutting. The first year's growth was cut back to within a few inches of the ground, and the second year's growth is now complete (November), and the cane is ripening. With the exception of cutting off all lateral growths to their first leaf as soon as they have grown about four inches, and removing all thin or weak shoots, and keeping the roots as dry as possible, nothing need be done to the vine until January when it should be pruned for fruiting.

Arbour—Mr. Cradwick writes as follows :—" The vines are now provided with an arbour" and he describes one erected at Hope Gardens, as follows :—" Four stout cashaw posts were inserted into the ground at four feet apart ; a piece of 4″ x 4″ pitch pine scantling fastened on the tops of these served as the end of the arbour ; a similar erection was made twenty-five feet from the first and from one to the other wires were stretched eighteen inches apart. The front of the arbour was four feet six inches high and the back six feet, thus giving a nice slope. Across the wires thus stretched the vines were trained."

Pruning—Mr. Cradwick says :—" At the first time of pruning (at two years old) the plants which had made a cane after being cut back to the ground, all the side shoots were cut off close to the main stem, a stronger growth being secured from the large bud which is always present at the base of the first lateral growth than from the lateral growth itself. With the older plants I tried various lengths of pruning the lateral growths, some being pruned back to within two, or even one eye of the main stem, and some were left four, five and six joints in length, as I had frequently been told that the close system of pruning practised in English hot-houses could not be carried out with success in Jamaica."

Mr. W. J. Thompson says :-"All vines which have been kept dry until now, (February) as I recommended in November last, should have the growth of last year's wood well ripened. The main stem of the vine should be kept as straight as possible. The side shoots should be cut back to a plump bud close to the old wood of the main stem, it being understood that the fruit of this year will be borne on the wood of last year. Vines that have been ill-used by being pruned twice in the year should not be pruned again until late in the spring. Grape vines should only get one general pruning each year ; more than this is injurious to them. Persons who have several vines with quite ripe wood should have begun to prune in December, and should prune one or two every fortnight so as to get a succession of fruit. With enough vines and proper treatment, grapes can be had most of the year. After pruning, the vines grown on a flat arbour may be left as they are, but those grown on a trellis should be laid or tied down to a level with the bend in the main stem, to enable the plant to push its buds evenly over the vine, instead of pushing just at the top of the shoot as would be the case were the stem trained up the trellis."

The Rev. Mr. Griffith writes :—" At the end of the first season the grower will have to decide how he will train his vine, whether on the usual flat arbour, trellis, or as a standard. The first is, perhaps, all things considered, the best—the second is the method I personally prefer, and the third is only possible with vines of robust growth. Under the usual flat arbour system, vines seldom receive any attention beyond watering until the time comes for annual pruning when sometimes a cartload of worthless growth, which never should have been allowed, has to be cut away. This is generally a disagreeable task. By the second method it is easy to see and get rid of any useless growth as it appears, and thus the whole work of the vine is concentrated on the maturation of the growing crop and the canes necessary for the production of the following crop. Very little is done in the way of producing a good cane until after the crop is entirely removed ; then all laterals should be shortened back, and any new sappy growth removed entirely, in order that food may be stored up in the new bud, and this process is constant during what, to the outward observer, seems to be the dormant season.

" As a rule the question of next year's crop is settled a year ahead. Pruning does not give fruit, it only settles its method of distribution over the vine when the cane has already been well grown ; it does, however, when skilfully performed, help very much in securing good canes well placed for the following year.

"Two systems of pruning commonly prevail. Each has its advocates and both have their uses. The older and more generally followed method is what is known as close or spur pruning. This gives good results generally, and in the case of some varieties gives the best results, but some kinds, notably Gros Maroc, Barbarossa, and a few others, are practically barren when so treated.

"The other, and in certain cases the better method, is to leave from two to three buds on the cane when pruning in the spring. By this plan, larger and looser clusters are secured and the labour of thinning lessened greatly, and in my opinion, a better and heavier bearing is secured.

" The proper time for pruning in Jamaica is any time between the end of January on to the middle of March. If the season is dry and warm the commencement of pruning may usefully be delayed longer. But if the year opens with showers followed by warm sunshine, to delay the work of pruning would result in severe bleeding which, however, abates as soon as the buds swell. There is very little to be gained by early pruning before the sap is stirring. A month's difference in the date of pruning vines of the same variety seldom makes more than a week's difference in the time of ripening of the fruit. The later pruned vines certainly yield the larger and better crops.

" As far as possible a vine should be pruned each year at or near the time when previously pruned, and this should be not oftener than once a year. From the Frontignan and Foster's Seedling, both very early grapes, two crops can be got under high cultivation, but the vines soon wear out."

Mr. A. F. Barron, says:—"We prune our vines to the end that we may obtain fruit. This is an obvious reason, though the mere act of pruning can only to a very limited extent assist in the production of fruit. By pruning we take away many of the fruit-producing parts, but we concentrate force or power on the others. The more complete the maturity of the buds, the more likely is the fruit to be produced, so that in pruning for fruit, if the wood is badly ripened, it is not advisable to prune too closely. Well-ripened vines will, however, produce fruit from nearly every bud, so that the danger of losing a crop by too close pruning is not very great."

TREATMENT AFTER PRUNING.

After pruning let the vines be thoroughly cleaned. Clear off the loose bark from the canes, but do not peel them too hard, unless infested by some insect pest, then wash them with soap and water to which some sulphur has been added. This will have the effect of thoroughly ridding the stems of any insect pests that may have found a hiding place beneath the loose bark.

Watering—Mr. W. J. Thompson writes:—"The roots of the vines should not be watered for about a week after pruning has been done, then they should have a good soaking, not a few bucketfuls but a watering equivalent to a rainfall of about six inches, so that the whole of the roots will get well watered. Besides the watering at the roots it is of the utmost importance that the vines should be sprinkled over with a good syringe or hose. This should be done at least twice a day, and if it can be done several times a day the buds will push all the better. Syringing or sprinkling by means of a hose should cease as soon as all the buds have started to grow. If a copious supply of water is given at the roots when the vines are started into growth, they will not need any more until they are about to flower, when they should have another heavy soaking like the previous one."

The Rev. Mr. Griffith writes:—"After pruning, and when the new growth has begun, the vine must on no account be allowed to go short of water: periodical soakings of water—the warmer the better—should be regularly supplied. Too much is better than too little, as if the drainage is good, the soil will soon put itself right."

MANURING.

The Rev. Mr. Griffith writes:—"Top-dressings of manure in the form of heavy mulching during active growth are very useful. They keep the roots moist and warm and also add to the food supplies. The less the soil is afterwards disturbed the better. When stable manure is used constantly, a light dressing of lime every three or four years will be of benefit. Stable manure forms humus, and humus in the soil adds to its water-holding capacity, increases its warmth, helps it to hold elements of plant food and to convert fertilizers into a form assimilable by the plants. A good root run with plenty of food and drink at hand, will not only give you a healthy, fruitful vine, but will keep it so. Badly nurtured vines are exposed to numberless perils from both insect pests and disease, which healthy vines escape."

Mr. W. J. Thompson, writes:—"Before or after the watering recommended [after pruning in the spring], the border should have a dressing of a few inches in thickness of stable manure. This will prevent excessive evaporation and help to keep the roots in good condition."

DISBUDDING AND STOPPING SHOOTS.

Mr. W. J. Thompson writes to the following effect:—"As soon as the vine begins to send out its shoots, care must be taken to rub off all buds that are not required. When the shoots are about three inches in length they will show fruit if there is going to be any on the first growths. Most eyes that break will produce two or three growths, and the weakest one at each eye should be rubbed off. But if there are only two growths, and of about the same strength, then remove the one furthest from the old wood so as to avoid forming a long spur. After all the growths that are not required have been rubbed off, care should be taken not to allow any more growths to spring from the bases of the first side growths. Do not allow growths to remain too close together; twelve to fifteen inches apart is a good distance to allow, rubbing off all intermediate growths as they appear. It will be prudent, however, not to thin out the last superfluous growths until it is seen what fruit there is going to be. If there are no signs of fruit when the shoots are about six inches long it may be taken that there will not be any unless it is produced on the laterals, and this is often the case with black grapes.

"When disbudding is finished, the side shoots that are allowed to remain will soon attain a length of about eighteen inches. At this stage all the growths, except the leaders, should be stopped by having the growing points pinched off. The growths with fruit should each have the point taken off at the third leaf beyond the bunch, and the side growths without fruit may be stopped at about the same distance. Soon after the points of the laterals have been pinched off, sub-laterals will begin to appear; these should be allowed to grow until they have made five or six leaves and should then be cut back to one leaf, and as they keep growing, this process must be repeated.

"It is not wise to allow any fruit to remain on the leading growths, and if any clusters appear they should be pinched off at once.

"Unless the vine is several years old, has a good main stem, and is in good health, it should not be allowed to retain all the bunches that will appear; ten good bunches are better than thirty poor ones, and there is nothing that will ruin the constitution of a vine so much as over-cropping.

"The leading growths should not be stopped until about four months after the vine was pruned and started into active growth, then the growing points should be pinched out. This will cause the trunk to increase in girth.

"All laterals should be kept off the leading growths.

"As the vine gets covered with foliage it should get a great deal more water than it received during the first few weeks: the soil must never be allowed to get anything like dry. When about to flower it should receive a good watering to carry it over that period, and after that it should get a copious supply once a week until the fruit begins to colour, when water should be withheld for a few weeks.

"Young vines grown for field culture should be disbudded to one growth: those on trellises may be disbudded to one, two, three or four growths as the grower may think fit.

"If it should happen that the spring growth has not produced any fruit, the vine will require just as much attention as if it were bearing a crop. Next year's crop depends on the quality and condition of the wood grown and ripened this year.

"I have often had complaints about vines not fruiting, and on examination I have always found that this was due to heavy rains the previous autumn causing a lot of superfluous growths which were not removed, but were allowed to remain on the vines, with the result that the over-crowding of growths and foliage prevented the fruiting wood– that should have been—from being properly ripened, hence no fruit."

The Rev. Mr. Griffith writes:—"As the buds begin to open the fertile ones can be distinguished from the barren ones by the fluffy red tip that appears in the centre. It is wise economy when there is more than one cluster on one shoot to remove one of them. The blossoms nearest the main stem will give the most shapely, compact bunch; the flowers further away will give a looser but larger bunch. Disbudding must have attention. By disbudding we mean the rubbing off with the thumb and finger, where two or more buds show close together, all except one bud, the one left being the one in the best position, and also removing any buds which if left on would result in over-crowding.

"The next step is pinching back to the third or fourth leaf all fruit-bearing canes, and the tying in out of the way of the cluster any non-bearing cane that it may be desirable to retain as a fruit bearer for the following season.

"Most vines, if at all free-bearing, will show more fruit than they can properly mature. This raises the question as to how many and what clusters should be allowed to remain. Some shoots will only show one cluster, the majority will, however, be likely to show two, and now and again a cane may have three clusters. Here is a case in which two are not better than one and where three are worse yet. Never leave more than one cluster on one cane, and that not always the one that promises to be the larger. Well finished, medium-sized clusters are worth more than poorly finished, larger ones. Nothing is lost by restricting the crop but sometimes a great deal in the way both of weight and quality is gained by it. The crop left on should be distributed over the entire area of the vine as evenly as possible."

THINNING THE FRUIT.

Mr. Cradwick in 1897 wrote as follows:—" A properly ripened bunch of grapes is one in which every berry is ripened at one time. . . .

"With reference to the grapes which I have seen growing in Manchester and St. Elizabeth on the Savannahs at the back of Alligator Pond and on to Lititz, a black grape [Gros Guillaume, or Black Barbarrosa] growing into magnificent vines in an incredibly short space of time and producing bunches up to six pounds in weight, I did not see a really properly ripened bunch, as none had been thinned, so that only half the grapes were eatable, but this of course could be easily remedied as the grape mentioned really does not set very many more berries than could be ripened."

"The Rev. Mr. Griffith writes:—" After the fruit has set, no time must be lost in thinning. Free setters such as Frontignan, Foster's Seedling, Gros Colman, Royal Ascot and others will be irreparably injured by delay. Muscat of Alexandria, Bowood Muscat and Cannon Hall Muscat are shy setters, and thinning in their case may be safely delayed a while longer until it is seen what the set is. Ordinarily it is safe to say that from one-third to one-half of the berries may be cut out, but an experienced grower, more anxious for quality than quantity, would go yet further and take out fully two-thirds. In the case of long, loose straggling clusters, the bottom berries seldom are worth anything—they fail to develop and are slow to ripen—it is best to remove them and so have a shorter and much better looking cluster. Some varieties are heavily shouldered whilst others are destitute of shoulders. At the time of thinning these shoulders should either be carefully tied up or else cut out; to allow them to remain and press upon the body of the cluster will do mischief."

And again: " The next important duty is thinning out the young grapes as soon as possible after the fruit has set. Some varieties give little trouble in this direction. Muscat of Alexandria will require a light thinning; Muscat Hamburgh requires none, but Gros Colman and a host of others require from fifty to seventy per cent. of the set berries to be thinned out. The larger number is the safer, but few amateurs have the courage to go this length and when too late to mend matters they are sorry.

The operation should be performed with a pair of clean, sharp, fine-pointed scissors, and should be repeated when the fruit is about the size of a pea. On no account must the cluster be taken in the hand, but with a smooth bit of wood as fine as a match, and about six inches long, lift up and open the bunch so that the interior berries may be reached and cut out. A bone crochet needle with the hooked point removed does nicely. The principal thing to be aimed at is to leave just as much fruit evenly distributed over the entire surface as will make a compact bunch when fully grown, but leaving room for the shapely development of each individual grape."

Mr. A. F. Barron writes :—"Thinning the fruit is an operation of considerable importance, not only for the well-being of the crop of fruit, but also for the after or lasting well-being of the plant itself. The vine is extremely fruitful, so much so that were the whole crop of the bunches produced by it allowed to remain, the plant would soon succumb through over-fertility. It is easily possible to over-crop a vine, and where such has been the case it will take years for it to regain its former strength. It is quite impossible to form any estimate as to how many bunches or what crop a vine should carry, so much depends upon its health and constitution, on its surroundings, and on the subsequent management accorded it. A very good rule would be this : according to the surface of properly developed leaves, &c., so should be the crop of fruit taken. We know we must have so many good leaves for every pound of fruit, and the greater the amount of properly developed foliage allowed the better. If we bear in mind that all the colouring and sweetening matter which goes to the perfecting of the berries has first to pass through and be elaborated by the leaves, it will be seen that without a certain amount of healthy leaf-surface, good fruit cannot be produced. A vine with weak sickly foliage cannot produce or bear much fruit, and a vine whose foliage gets destroyed by red-spider, &c., is in exactly the same condition.

"As a general rule, one bunch on each spur would be considered a heavy crop. If one-third of these bunches were taken off, the bunches being of moderate size, what is left would be a moderate crop, say an average of one pound to every foot of rod. In thinning the bunches of such free-setting varieties as Black Hamburgh, every second bunch on each spur should be cut off before the flowers open, and all others which it is desirable to remove as soon as the grapes are set. The thinning of the bunches as well as of the berries should take place as early as possible. It is a great waste of power to allow that to develop itself which is not required, and which it is known must be cut away ; therefore, as soon as the berries are fairly set, thin out—that is, cut off—the supernumerary bunches at once, and commence the thinning of the berries.

"The thinning of the berries ,or grape-thinning as it is popularly called, is a delicate and somewhat tedious operation. To be expert at this work requires not only considerable practice, but a quick eye to see where and what to cut, and a nimble yet steady hand, so that the berries retained may not be injured."

"The mechanical operation of thinning grapes is thus performed :—Procure a little cleft or forked stick about six inches long to use with the left hand, in order to hold the bunch firmly without touching it, and take a pair of grape-scissors in the right hand. Trim the bunch, if required, into proper shape first, then continue by cutting out all the inner berries, next all the small berries, and then the side berries The expert hand will cut these off two or three or more at a time, not singly, as the hesitating, unpractised hand will do. The time that is occupied in thinning grapes is very great, but it must be given to the operation if good grapes are desired.

"With large bunches it is frequently desirable to tie the shoulders up, and so spread the bunch out, or loop them up to the trellis with S-shapen pieces of thin wire of the requisite length. Care must be taken not to make the bunches too thin ; loose spreading bunches are objectionable and easily damaged. They should be so thinned that when ripe and cut the bunch or cluster may remain firm and compact, whilst every berry has been allowed to develop itself freely to its full size.

"Very expert hands may be able to thin a bunch properly at one operation, but, as a general rule, they require to be gone over twice before the stoning period, and once after, during what is termed the 'second swelling,' in order to remove all small berries, and otherwise regulate the bunches.

"In the great grape-growing establishments the greater part of this work is performed by women and young persons who are nimble with their fingers."

DISEASES OF THE VINE.

Diseases of the Vine may be conveniently classed into :—

(1) Those directly traceable to the action of parasitic fungi.
(2) Those directly traceable to the action of injurious insects.
(3) Those for which neither fungi nor insects offer a sufficient explanation.

The second class of diseases we propose on this occasion to pass over.

FUNGUS DISEASES.

Anthracnose.

(Sphaceloma Ampelinum, De Bary.)

Description—This is a fungus which attacks all parts of the Grape Vine, but most commonly the berries. The name, anthracnose, means coal-disease, the disease is so called from the dark colouration of the affected parts.

When it first attacks the berries, circular brown spots are noticed, with a somewhat sunken surface, gradually enlarging in size. If there are several spots on the berry, they grow into one another, forming a large patch with an irregular line. As the disease progresses the skin of the centre spot may form a scab of a lighter colour—grayish and sometimes with a band of vermilion colour outside the centre.

It will probably be first apparent on the shoots of the vine, on which the spots extend lengthwise, giving them a speckled appearance when abundant.

It also attacks the leaves and especially the veins and stalks. The stalks of the clusters are often affected too, and when completely girded, all the berries below the disease-ring remain green, and shrivel up.

Treatment—When it is known that a vinery is liable to be attacked by this and other fungus diseases, spraying with Bordeaux mixture should be commenced as soon as the first leaves have fully expanded. The second application may be made after flowering, and the third from 2 to 4 weeks later, according to whether the weather is favourable to the disease. The Bordeaux mixture may safety be used until the berries are three-fourths their full size. After that the application may leave a stain which would reduce their market value, and it is better to use the ammoniacal carbonate of copper about every 10 days even after the fruit is fully formed, if the disease is rampant.

The clusters should be sprayed as well as the leaves, especially when they are young. The reason for several applications is that the spores of the fungus resist successfully every destructive agency and it is only when they have already germinated that they can be killed. Everything depends upon the thoroughness of the spraying, and each vine should receive about one quart of liquid at each application.

Besides the use of the Bordeaux mixture, it is customary to treat the vines in the winter months when they are bare of leaves and dormant, with the sulphuric acid and sulphate of iron solution, applied by means of a brush or a swab made of rags tied around the end of a stick. The effect on the wood is to blacken it which is looked upon as a test of the thoroughness of the work, and whenever the colour remains after 2 or 3 days, a second application should be made.

BLACK ROT.

(Loestadia, Bidwellii, V. & R.; Phoma uvicola, B. & C.)

The Black Rot is even more destructive than the "anthracnose" and besides causing the rotting of the fruit, attacks the leaves and shoots.

Description—It is readily distinguished from anthracnose by the centre of the dark disease spots having a number of minute pimples, from which the spores come, and are carried by the lightest breeze to other berries and to other parts of the vine.

It does not attack the stalks of the clusters, as in anthracnose; and on the leaves it is found originating between the veins, not on them, and has minute pimples in a band near the edge of the affected part.

Grapes are nearly or quite full grown when the disease appears. The spots are first purplish-brown, the whole berry then becomes affected and gradually turns black and the pimples make their appearance. The grape at the same time shrivels, but does not fall off, and the seeds are clearly seen under the skin which become drawn and ridged.

Treatment—Bordeaux mixture should be used, first before the buds open, a second time when the leaves are one-third grown, a third time just before flowering, a fourth time two weeks later. The fifth application two weeks later should be the ammoniacal copper carbonate solution, and a sixth application of the same may be necessary. If the weather is dry, the number of sprayings may be less.

DOWNY MILDEW, BROWN ROT.

(Peronospora viticola, De Bary.)

Description—Although this downy mildew, attacks all parts of the vine, the chief mischief is when the leaves are diseased, as then not only the present, but next year's crop is in danger.

The leaf first turns lighter green where diseased, then yellow, and lastly brown, while if the under surface is examined when the upper has begun to turn yellow, it will be found to be covered with minute threads growing out from the substance of the leaf.

The grapes are usually attacked before they are half-grown, first turning brown (brown rot), and afterwards grayish (downy mildew).

Treatment—If the downy mildew is feared the shoots should be first sprayed with Bordeaux mixture when they are only from six to ten inches long, and afterwards on flowering and at intervals of from 2 to 4 weeks.

POWDERY MILDEW.

(Uncinula spiralis, B. & C.)

Description—This fungus spreads only on the outside surface of the vine though it sends suckers into the cells immediately below, feeding on their contents and changing the green colour into brown. The fungus itself is of a grayish white colour, and easily rubs off the leaf, shoot, or grape, when the destruction of the green colour is very noticeable. It is generally found on the upper surface of the leaves, which distinguishes it from the Downy Mildew. It develops best during dry weather.

Treatment—As this is only a surface fungus, not penetrating beyond the outer cells, it is not so dangerous as those previously mentioned, and the vines do not require treatment for it, until it has actually made its appearance.

Sulphur is applied either dry or mixed with water, but this remedy is not considered so valuable as spraying with carbonate of copper dissolved in ammonia.

EUROPEAN MILDEW.

(Oidium Tuckeri, Berkl.)

Description—This mildew resembles the Powdery Mildew in general appearance, and like it, is a surface mildew. When it attacks the fruit, the skin of the grape is unable to expand, and bursts.

Treatment—Flowers of sulphur dusted over the diseased parts effectually disposes of this fungus.

RATTLES; SHELLING.

Description—Just as the grapes are ripening, they begin to fall off, and this takes place first at the extremities.

Treatment—As the chief cause of this disease is defective nutrition, manure should be applied, and especially potash.

RIPE ROT.

(Glœosporium fructigenum, Berkl.)

Description—The grapes are attacked in the ripening stage. A reddish brown spot first appears which gradually spreads over the whole grape, then black pimples appear which are not so numerous as in Black Rot, but they are broader.

The colour remains dark purplish brown, and the diseased grapes fall to the ground; whilst in Black Rot, the colour is black, and the grapes do not fall off.

Treatment—If there are only a few vines, the grapes affected may be picked off and burnt, but where there are a large number, the same treatment should be adopted as for Black Rot.

Fungicides.

BORDEAUX MIXTURE.

Bordeaux Mixture is best made according to the following formula:—

Copper Sulphate	...	6 pounds
Unslacked lime	...	4 pounds
Water	...	50 gallons

It requires careful mixing, or the ingredients will not combine properly. Put 25 gallons of water into a barrel. Tie up 6 pounds of copper sulphate into a piece of coarse sack, and hang this by a stick laid across the top of the barrel so as to be just beneath the surface of the water until it has slowly dissolved.

In another barrel slack 4 pounds of lime very slowly and carefully, at first only adding about a quart of water at a time, until a perfectly smooth paste free from grit, is obtained. Add water to make the whole 25 gallons, and wait until cool. Now pour both together into a cask holding 50 gallons. The milk of lime should be thoroughly stirred before pouring, and finally the mixture should be well stirred for 4 or 5 minutes with a wooden paddle.

If not perfect, the mixture is liable to injure the foliage and in order to test this, put the blade of a penknife into the mixture and leave it for 1 or 2 minutes. If there is any deposit of copper on the blade, showing a brownish colour, it is not safe to use it, and more lime must be added until the knife is not discoloured.

SULPHATE OF IRON (COPPERAS OR GREEN VITRIOL.)

Against anthracnose of the grape the following application has shown itself to be of great value, and it is regularly used by European vineyardists.

> Water, (hot), 100 parts.
> Iron sulphate, as much as the water will dissolve.
> Sulphuric acid, 1 part.

Great care should be exercised in using this preparation, as it is exceedingly caustic and will injure machinery, clothes, and nearly everything with which it comes in contact. It is generally applied with a swab made by tying rags about the end of a stick. Dormant vines are uninjured by the treatment.

UNEXPLAINED DISEASES.

The unexplained diseases of the Vine are important enough to merit special notice, as they have been the subject of many investigations. As a general conclusion of the perusal of some of the more important results obtained, we are led to regard most of the unexplained diseases as "physiological," that is, they are due to defects in cultivation, to adverse climatic or other conditions, and to the use of unsuitable varieties of the Vine. Fungi or insects may appear along with diseases of this kind, but they come later and only because the plants are already weakly. One might even go further, and say that most of the fungus-diseases of the Vine are really started by defects in cultivation: the Vines are weakened, the fungi come and complete the mischief.

The methods employed to produce a large supply of fruit of high quality may easily result in conditions favourable to the development of disease.

SHANKING.

"Shanking" is a trouble which accompanies grape-growing all over the world. The grapes as they approach maturity fall off the bunch, breaking away where the stalk joins the fruit; or they may simply shrivel up and remain attached. The grapes to go first are those towards the lower end of a bunch, or those on the shoulders.

The number may vary from one to many, and the trouble may be apparent all over the vine or only on parts of it. The foliage is at the same time more or less affected; generally the leaves turn brown and curl in places, or all over. Insects or fungi have never been proved to be the real cause of the trouble, the chief reason is to be sought in the condition of the vine itself. No doubt, the disease is not always due to the same cause. Overcropping frequently leads to "shanking," so, also, does too early ripening of the wood. Both of these conditions result in a drain on the food-supplies which the plant has to provide, and will lead to starvation of maturing fruit. Excessive moisture and heat produce conditions favourable to "shanking" if they cause undue forcing of the vines; on the other hand, any check due to sudden dryness or cooling will be first seen in the fruit bunches.

From what we can learn, the soil itself has no direct effect, but a weak root-system due to defects in the air, heat, texture, or moisture of the soil, will not be in a condition to supply the necessary water and food to a fruiting vine. Excess of nitrogenous substances in the vine due to over-manuring or to over-cultivation of a rich border, easily aggravate "shanking." It is said by good authorities that "shanking" occurs when the vine is deficient in potash, and they recommend this to be supplied in some form as a manure to the soil. Dropping of the grapes is also a common result of any disease of the foliage, stems, or roots of the vine.

BLANCHING.

"Chlorose" or "blanching," is a disease which has caused much trouble in the south of France. The vine-leaves lose their deep green shade, then become yellow or completely blanched. The loss of colour generally begins near the margin of the leaf, and spreads inwards between the veins; the affected parts may or may not become withered. Young green twigs sicken like the leaves, and may dry up. The woody branches are retarded in growth, and new leaves given off remain small and blanched. As the malady almost always develops before the flowering period, both flowers and young fruit are stunted and discoloured, and probably dry up or fall off. French experience shows that chlorose is worst on very limey calcareous soils. On such soils the vines sicken in the first year, and gradually lose their vigour; death may ensue, but frequently the vines recover gradually each year, and the chlorose may disappear. Where the soil is less calcareous, the disease is less intense. On clay or siliceous soils, chlorose only appears in some cold wet spring, when yellow patches may appear on the leaves, but growth is hardly interrupted, and if the weather improves, all comes well again. The primary cause of chlorose is the presence of too much carbonate of lime (limestone or chalk) in the soil, and its action is assisted by any condition of the soil which increases the amount of soluble lime. This is further assisted by want of water, light, heat, or air, which defects tend to weaken the general health of the vines. The disease is diminished by any mode of cultivation which promotes good drainage in the soil, or which strengthens the growth of the vine. Above all, applications of sulphate of iron (green vitriol) to the soil round the roots of the vine do most to cure chlorose; this is the case, even though the soil naturally contains iron. As many of the great vine-growing districts of France have a calcareous soil, chlorose is a serious disease, and, during the Phylloxera epidemic, it assisted in almost exterminating the vine, and in ruining many a grower. During recent years, however, great progress has been made in checking both Phylloxera and chlorose. This is done by selecting vines produced by grafting the European vine (Vitis vinifera) on stocks of American vines. Briefly, however, certain varieties of Vitis vinifera grow fairly well on calcareous soils (e.g., Folle-Blanche, Pinot, Colombeau, etc.); these are grafted on stocks of the American Vitis Berlandieri, which is found wild only on calcareous soils. The Vinifera-Berlandieri hybrids have been used to re-stock hundreds of acres in France, and the grapes produced are not inferior in quality, while the vines are much more resistant to disease. This is an important chapter in the history of vine cultivation, and illustrates the great value of resistant varieties or hybrids as a means of combating diseases of plants. We believe that more substantial progress will be made against diseases of plants by means of hardy varieties than by any methods of spraying or sulphuring sickly plants. (Wm. G. Smith in *Gardeners' Chronicle*).

VARIETIES.

European varieties are described in the Bulletin for September, 1887, and March-April, 1894.

In 1903 cuttings of the following varieties of American grapes were received from Messrs. T. V. Munson & Sons, Denison, Texas, for trial in Jamaica, and are being grown at Hope Experiment Station :—Blondin : Brilliant : Calabrian : Captain : Carman : Cloeta : Feher Szagos : Fern Munson : Herbemont : Herman Jaeger : Kiowa : Manito : Perle of Anvers : R. W. Munson : Violet Chasselas : XInta.

Mr. Cradwick writing in 1897, says :—" Of the white varieties which we have grown, I think the Muscats are the only grapes worth growing to any extent ; these ripen up easily and uniformly. We have grown other white grapes, the best of which are, Raisin de Calabre and Foster's Seedling, but neither of these can be compared with the Muscats, either for quality or for productiveness. Another great point in favour of the Muscats is that they require very little thinning, a most tedious process with most varieties. Black grapes are not favourites in Jamaica, for what reason I cannot tell, except perhaps that with nearly all the black grapes, about five times more berries grow on each bunch than can possibly find room to grow to maturity, thus necessitating a lot of thinning. If this is not done, and at exactly the right time, the bunches are spoiled. Black Hamburg is perhaps the finest flavoured of all black grapes. Black Alicante has borne fairly well, producing nice bunches of very fine dark-coloured berries of fairly good flavour, but the thinning is the bugbear with this variety. Gros Colman, that most showy of all grapes, although it is never as good as it looks, has proved a failure. It puts out the most promising looking bunches which grow and swell up in the finest style imaginable until the berries commence to colour, when they crack and fall off, until by the time they are ripe there are only six or eight berries on a bunch which, had it ripened properly, would have weighed two or three pounds."

And in the Annual Report for 1896-97 he writes as follows :—" With reference to varieties, as far as it has been possible to determine at Hope, the varieties to be grown on a large scale must be selected from the following :—Black Hamburgh, Black Alicante, Muscat of Alexandria, Raisin de Calabre. Of other varieties, tried

Gros Colman has turned out a failure; it produces large quantities of big bunches which have large berries up to the time when they begin to colour, when they split and fall off. Monukka and Trebbiano have also been given an extensive trial but have failed to produce any fruit."

And again in the Annual Report for 1898-99:—"The grape vines bore a large summer crop which commenced to ripen about the middle of May and lasted until the end of July. The variety first to ripen was Raisin de Calabre, and after that Foster's Seedling. The Muscat Hamburgh turned out fairly well, as did also Royal Ascot and Black Prince, but of the black varieties, Alicante appears to be best suited to the Hope climate, as it is the only variety not attacked by mildew. The Muscat of Alexandria has again proved to be the best of the white varieties. Foster's Seedling is a heavy cropper."

The Rev. Mr. Griffith writes:—"Madresfield Court is a magnificent grape and it is a pity that it does not do well with us. A handsomer grape when well grown cannot be found, and for quality it is difficult to beat. Foster's Seedling is very fruitful but requires a great deal of care and is only a second-class grape when at its best, but where grapes are in demand, and earliness with good looks count, it is worth while to grow. Muscat of Alexandria will give good fruit under any method almost. When cut back to one eye (in pruning) the clusters are not large but they are compact, handsome and heavier than they look. Pruned to three or four eyes, the clusters will be larger, but looser and not by any means so good in appearance.

"Tastes differ and no one variety suits everybody. At the head of the list we must put Muscat of Alexandria. The green shoots in young vines of this variety are apt to suffer from 'black rot,' but about half a pound of powdered sulphate of iron dusted over the soil and raked in will remedy this evil.

"As a second vine, where more than one can be grown, my choice would be either Royal Ascot, Mrs. Pince's Black Muscat, or Madresfield Court, Alicante or Alnwick Seedling. These are all black grapes. Royal Ascot is a free bearer, the clusters never turning the scale at over a pound, and oftener weighing from eight to ten ounces, but the grapes are very handsome and the quality excellent. Mrs. Pince is a Muscat grape having the same flavour as Muscat of Alexandria; it is a free bearer, and in every way a desirable grape. Madresfield Court I have grown, but it is difficult to grow well, and I have oftener failed than succeeded. Where room is ample I would, however, recommend a trial. Alnwick Seedling is handsome, good flavoured, very fruitful and not difficult to grow well; the berry is quite as large as Muscat of Alexandria, and it is a mid-season or late grape."

And later he writes as follows:—"Muscat Hambro, one of the most delicious grapes, is an utter failure; it makes good canes, shows plenty of bloom, but the clusters are skeletons.

Gros Guillaume, commonly, but erroneously known as Barbarossa, is most handsome both in bunch and berry; Lady Downe's

Seedling, a black vinous grape, is subject to black spot which appears on the berries as they begin to take colour, and utterly ruins them. It is regarded in England as the very best late keeping black grape. The native grape of North America does not succeed with us.

Vines are usually classified as early, mid-season, and late, according to the time when their fruit generally matures, and also to the length of time between starting into growth after pruning and the fruit becoming fully ripe. Included in each of these classes we find representatives of all sizes, colours and qualities.

"In the first section are included all the Frontignans—white, black, red and grizzly. When well grown there are few grapes that surpass the Frontignans in flavour. They are, however, difficult to grow well, the fruit is tender; and warm, wet weather will ruin the entire crop when ripening; both bunch and berry are small and in the desire for large, showy fruit these excellent grapes have fallen into neglect.

"Foster's white seedling" is another early grape, perhaps the very earliest. It is a prolific bearer and when well grown there are few handsomer grapes. It also sets its fruit well and in thinning not less than two-thirds of the berries should be cut out which will enable the remaining berries to obtain a good size, and no weight of crop will be sacrificed. The fruit is very delicate and tender, and when gathered must be carefully handled or the cluster will be spoiled. So soon as the fruit begins to colour all watering should cease.

"The 'Black Hamburgh,' as its name indicates, is of German origin. This is an early grape of the highest quality. As a general purpose grape it may be said to hold the premier place among black grapes, although for some reason it has fallen somewhat out of favour in recent years. If pruned at the same time as Foster's seedling, its fruit will mature three weeks or more later than that variety. It does best under close pruning; the bunches are more compact and the berries larger. It is impatient of heavy cropping; the lighter the crop the higher, as a rule, the quality and the healthier the vine.

"Madresfield Court" is a grand grape in every way. When well grown, which is unfortunately seldom the case, it is almost without an equal. The cluster is not large but the berries, which are a clear purplish red, are very large and oval. Like "Foster's seedling" it is impatient of moisture, and when ripening likes a dry, warm atmosphere.

"In the mid-season section we have Alnwick seedling," "Gros Maroc," Mrs. Pince's Black Muscat" and "Royal Ascot," all black grapes. In the order of merit I give "Mrs. Pince's Black Muscat" and "Royal Ascot" an equal first place, Alnwick seedling the second, and Gros Maroc the last. The first three are all free bearers, Royal Ascot bears immense quantities of small bunches of big grapes, the bunches seldom weighing over eight ounces. When the fruit is setting not less than 70 per cent. of the berries should be thinned out. Alnwick seedling is easier to grow and gives less trouble than any grape in cultivation. Gros Maroc is not a free bearer and is late in coming into bearing. There are, however, few better looking grapes, and scarcely any so poor in quality. It is largely grown, principally, no doubt, for its good looks.

"Out of the section of 'Late Grapes' we have five that may be said to head the list , three are black, viz. : Alicante, Gros Colman, and Lady Downe's seedling, and two that are white :—Mrs. Pearson and Muscat of Alexandria. Canon Hall Muscat and Bowood Muscat are regarded as cultural varieties of Muscat of Alexandria. The three black varieties are vinous grapes in contradistinction to the sweetwater and muscat flavoured varieties. When fully ripe they have a very distinct port wine bouquet. They are all free setters and require severe thinning. Gros Colman is the handsomest in both berry and bunch ; Alicante is the easiest to grow and Lady Downe's seedling, which is a confessedly difficult subject is, when finished, by far the best keeper and the best flavoured. They all take on a better colour and preserve their bloom better when grown with some shade from the foliage ; the ripening is also more uniform. Of "Mrs. Pearson" I cannot speak from personal experience ; I have never grown it and do not know that I ever saw it growing. It has the reputation of being the latest white grape in cultivation and an excellent keeper.

"Muscat of Alexandria is a universal favourite. More vines of this variety are grown in Jamaica than of any other and it is not difficult to grow well. It is by far the best mid-year and late grape in cultivation and well-grown and thoroughly ripened, leaves nothing to be desired as a dessert grape.

"When grapes are grown simply for home consumption, and only one vine can be grown, Muscat of Alexandria should be selected. Where there is room for two or more vines and the duration of supply is desired, Foster's White seedling for early use and Lady Downe's seedling or Alicante would be serviceable as a late supply. Alicante is easy to grow, a free bearer and in many ways a desirable variety.

"When grown for commercial purposes the varieties selected should he confined (unless the operation is to be on a large scale) to not more than two kinds, one white and one black. By extending the period of pruning and starting into growth over say from the end of January to the middle of March it should be possible to market fruit from the end of May to the end of September or later."

MARKETS FOR GRAPES.

The following letter from Messrs. Gillespie, Bros. & Co. appeared in the Bulletin for June 1896 :—

"We beg to lay before you the following regarding English (or Hot-house) Grapes. These are saleable here during the winter months, the price depending considerably on the condition in which they are received here, as high as $2.00 per pound being paid for the sound, and their least value would probably be $1.00 per pound.

"They should be packed in baskets of about ten pounds each, well protected against "bruising" by introducing between and around each cluster *excelsior* or other local substitute.

"To ensure their arriving here sound, it will be necessary to have them brought on in the ships' refrigerator.

"The duty here is 20 o/o on invoice value.

"Native grapes (grown in U. S.,) are expected to come to market in May, however, if you have any fit for shipment at present we would recommend that you send on one basket of about 10 lbs. in order that buyers might get a chance to judge of the Jamaica article which at present is comparatively unknown here, and we ourselves would then be better in a position to offer fitting suggestions as to future shipments of these from your Island."

The following statement appears in the Annual Report on the Public Gardens for 1898-99 :—

"Whether it will be found possible eventually to produce grapes from January to March for the London and New York markets is still a matter of experiment, but there is a local demand at remunerative prices even for summer grapes."

In a letter dated 23rd February, 1903, and addressed to the Director of Public Gardens, Messrs. T. V. Munson & Sons, Denison, Texas, U.S.A., state as follows :—" Fine grapes sell at the highest price in our large cities during winter. Then the Malaga grapes from Spain, packed in cork dust, are in all our city markets, and sell at 20 to 30 and 40 cents a pound. The demand would continue up to June."

Season for Grapes—The Rev. W. Griffith writes as follows :—"The natural season with us for grapes appears to be between the beginning of the month of May and the end of August. During these months excellent grapes, both white and black, are sufficiently plentiful in and about Kingston to meet a good local demand. Outside these months they are occasionally offered for sale in Kingston, but as a rule they are poor, having evidently received no cultural care. This is especially the case with black varieties, which are seldon properly ripened. This, no doubt, is in part the reason why black grapes are so little appreciated by us, and it is a pity, as some of the very best grapes are black."

SUMMARY.

1. *Propagation*—Prunings obtained in the spring may be used for propagating the vine by cuttings.
2. *Selection of Site*—The site for a vinery should be selected as far as possible from large trees, and where plants will receive all the sun possible. It should have a southern aspect.
3. *Preparation of the Border*—Whilst the young plants from cuttings are growing, the border, or suitable holes should be prepared as directed.

4. *Planting young Vines*—The young vines should be planted out about the beginning of May in the specially prepared border or holes, at distances of four or five feet apart, and as they grow, each one should be trained up a straight, stout stick,

   Keep supplied with water and encourage growth during the summer. Allow them to dry off and ripen during late autumn and winter.

5. *Pruning and Training*—At end of February or beginning of March cut the young vine down to within three or four inches of the ground, and when growth starts only allow the strongest shoot to grow to form the permanent vine. Keep it trained straight as it increases in growth, and pinch out the points of the side branches as directed.

   Induce the plants to make good growth during the summer and on till September or middle of October, when they should be kept dry to induce the canes to ripen thoroughly and produce fruit next season.

6. Prune in February or March as directed at page 8 and provide an arbour or trellis to train them over.

7. After pruning attend to watering and manuring as directed; thin fruit; attend to disbudding, and train and stop laterals and sub-laterals; keep dry when fruit is colouring or the berries will crack; keep the roots as dry as possible from end of September or beginning of October to end of January when the plants should again be pruned.

Information on Grape Vines may be found in the Bulletin of the Botanical Department, and of the Department of Agriculture as follows:—Grape Vines at Hope Gardens, 1895, 219; 1897, 285; 1899, 198; Cradwick, Wm., on, 1896, 121; 1897, 7, 145, 285; 1899, 198; Cultivation, 38, (4); 1894, 55; 1897, 145; 1898, 95; Disbudding and stopping, 41, (4); 1894, 55; 1898, 101; Diseases and remedies, 1897, 37; 1899, 161; Grapes for United States Markets, 1896, 123; Griffith, Rev. Wm. on, 1898, 95; 1904, 51; Manuring, 1898, 98; Persian, 1896 270; Planting young vines, 41 (3); 1896, 121; 1896. 146; 1898, 98; Propagation by cuttings, 4 (3); 1897, 9; Pruning, 40 (6): 1897, 7, 147; 1898, 100; Seedless Grapes, 1899, 139; Site for Vineyard, 1898, 97; Thinning fruit, 1897, 147; 1898, 107; Thompson, W. J. on, 38 (4); 40 (6); 41 (3); 1894, 55; Training, 1894, 55; 1897, 146; 1898, 99; 1905, 6; Treatment of neglected Vines, 38 (4); Variation in colour of Grapes, 1902, 55; Varieties, with descriptions, 1894, 56; 1898, 95, 102; Watering, 41, (2); 1897, 147; 1898, 101, 102; 1903, 115.

BOARD OF AGRICULTURE.

EXTRACTS FROM MINUTES.

The usual monthly meeting of the Board of Agriculture was held at Headquarter House on 12th December; present: Hon. H. Clarence Bourne, Colonial Secretary, Chairman, the Director of

Public Gardens, the Island Chemist, His Grace the Archbishop, Messrs. C. A. T. Fursdon, J. W. Middleton, G. D. Murray, and the Secretary, John Barclay.

Instructor for School Gardens—The Secretary read letter from the Colonial Secretary's Office acknowledging receipt of the recommendations of the Board with regard to an Instructor for School Gardens, and stating that His Excellency had approved of the recommendations as follows :—

1. That Mr. Percival Murray be appointed as Instructor for school gardens work at an addition to his present salary as an officer in the Chemist's Department of £50 per annum, with £100 travelling expenses, the necessary provision to be made on the estimates of the Education Department ; that the £100 would not be provided as a fixed allowance but as the maximum travelling expenses to be re-imbursed the Instructor and only the amount of his certified expenses would be allowed him ; that provision for the service would be made as an experiment for one year only, and no pledge would be given by the Government to continue the service, as His Excellency hoped that eventually each Inspector of Schools would be found qualified to inspect school gardens and to encourage agriculture.
2. That His Excellency approved of the printing of Mr. Williams' book on school gardens at the Government Printing Office, provided that an estimate of the cost of printing the requisite number of copies was obtained from the Superintending Inspector of Schools and was found not to be unduly large.

The Conference—The Secretary read letter from Sir Daniel Morris with reference to the West India Agricultural Conference, stating that he would be glad of the assistance of the members of the Board, and of any suggestions that the Board could offer with regard to subjects to be brought before the Conference.

The Chairman explained that the arrangements had been taken in hand by the local organising committee.

High Ether Rum—The Secretary read letter from the Secretary of the Northside Sugar Planters' Association asking when the report on the High Ether experiment at Hampden could be expected, and stating that the members of the Association would be glad to accept the offer of the Island Chemist to attend at their next meeting on the 5th January, next, at 2 p.m. in the Court House, Falmouth, so as to receive the suggestions he proposed to put forward.

Work of Instructors—The following letters from the Colonial Secretary's Office were submitted :—

1. Transmitting copy of correspondence with the Agricultural Society on the question of the Joint Committee's direction of the work of the Agricultural Instructors and stating that if the Board of Agriculture and the Jamaica Agricultural Society were agreed, the Governor approved of

the proposed Joint Committee dealing with the actual direction of the work of the Instructors, on the understanding that the Government's control over its own officers remained unimpaired and its right to utilize their services for special work was recognised.

It was agreed to wait until the Agricultural Society had considered the letter.

Varieties of Cane—2. Letter from Mr. Cousins asking that authority might be given for the vote of £20 for the purchase of cane tops on the estimates of the Hope Experiment Station for the current year to be utilised for the preparation of two acres of land for extending the area of canes, for testing varieties and distributing to estates, and stating that it would be more useful to expend this money on increasing the supply of cane tops at Hope rather than in purchasing tops from abroad; the land was available, and the Director of Public Gardens was willing to allow the extension.

This was approved of.

The following papers which had been circulated were now submitted for final consideration:—

1. Report on Enquiry into the Commercial Aspects of Jamaica Rum in the United Kingdom and Germany.
2. Proposed Experiments in forcing early oranges.
3. Report on Distillers' course.

Early Oranges—As regards the experiment in forcing early oranges, the Chemist was asked at whose expense this would be carried through—if at the expense of Colonel Kitchener.

The Chemist stated that there were some departmental allowances for appliances which could be used for the experiment.

This was approved of.

[Issued 20th Feb., 1907.]

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BULLETIN

OF THE

DEPARTMENT OF AGRICULTURE.

Vol. V. FEBRUARY & MARCH, 1907. Parts 2 & 3

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.,

Director of Public Gardens and Plantations.

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PRICE—Threepence.

A Copy will be supplied free to any Resident in Jamaica, who will send name and address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
HOPE GARDENS.

1907.

JAMAICA.

BULLETIN

OF THE

DEPARTMENT OF AGRICULTURE.

Vol. V. FEBRUARY & MARCH, 1907. Parts 2 & 3.

WEST INDIAN AGRICULTURAL CONFERENCE, 1907.*

The President and Representatives of the sixth West Indian Agricultural Conference arrived at Kingston, Jamaica, in the Imperial Direct West Indian Steamship 'Port Kingston' at day-break on Friday, January 11th, when they were met by His Excellency the Governor, the members of the Reception Committee, and a large number of the principal officials, men of business, and planters of the island.

Arrangements had been made for a number of excursions to various parts of the island. One party paid a visit to St. Catherine to see the banana [under irrigation on Mr. Hotchkin's estate]; rubber and citrus cultivations, and the cassava starch factory at Eltham Park. The Vere district was visited by another party, where opportunities were obtained of seeing banana cultivation under irrigation, and the cotton cultivation of the Vere Estates Co. Ltd.; after the sugar works at Money Musk had been inspected, the party proceeded to the citrus grove of Dr. Tillman at Camden, which is probably the best of its kind in the West Indies. On the return journey, the representatives were able to see the new central sugar factory which is in course of being erected at Parnassus.

On the following day most of the delegates availed themselves of an invitation to visit Port Antonio as guests of the Hotel Titchfield. The special train by which the party travelled made stops at Highgate and Orange Bay to enable the visitors to inspect banana and cacao cultivations. A ball was given at the Hotel Titchfield on Saturday evening.

On Sunday, January 13, a special service was held at the Kingston Parish Church, when his Grace the Archbishop of the West Indies was the preacher.

On Monday, January 14, the Conference was opened at the Old Mico School-room in Kingston, by His Excellency the Governor, Sir Alexander Swettenham, K.C.M.G., who expressed his great pleasure in welcoming to Jamaica the Conference delegates and

* From "Agricultural News," VI., 125; 9 Feb. 7.

the influential and distinguished company brought out by Sir Alfred Jones. Conferences of this kind were, he declared amongst the agencies which made for the progress of the West Indies, and he hoped their deliberations would be fruitful of benefit to those concerned.

Sir Daniel Morris then delivered his presidential address. He said it was a source of satisfaction to him that it had been possible to arrange for this Conference to be held in Jamaica, where he had spent some of the best years of his life, and in which he continued to take deep interest. Probably, in no part of the tropics could be found such diversified industries as existed in Jamaica, and it was, in consequence, singularly favourable as a meeting place for those interested in agriculture. He referred gratefully to the thoughtful arrangements made by the Reception Committee, which had afforded the delegates opportunities of becoming acquainted at first hand with some of the special industries of Jamaica.

In the course of a review of the agricultural conditions of the West Indies since the last Conference, held in Trinidad in January 1905, the President stated that progress was being made in every direction. New industries were being added, and old industries were being revived and developed. Referring to the general anxiety felt throughout the colonies where sugar is a staple, as to whether the Brussels Sugar Convention was likely to be continued, he announced that after careful consideration he had decided to appoint a committee consisting of representatives closely connected with the industry, which would prepare replies to the following questions: (1) What has been the effect of the Convention in the West Indies? (2) What effect has the recent uncertainty as to its continuance had? (3) What would be the probable effect of its non-continuance? The report would be likely to be of value when the question of the continuance of the Convention was under consideration in the Mother Country. Attention was also drawn to the position and prospects of West Indian sugar in the Canadian market. This was followed by a review of efforts to extend the cultivation of cacao and citrus fruits in Jamaica. The value of cacao exported from Jamaica in 1906 was £75,000: of citrus fruits, £99,689.

In regard to the cotton industry, the President pointed with reasonable pride to the rapid progress that had been made during the last four years. There were now 18,000 acres in the islands under cultivation in cotton: of this, 15,000 acres were planted with the best varieties of Sea Island cotton that commanded the highest prices on the English market. The value of the cotton lint and seed exported from the West Indies was estimated at £200,000. References were also made to the rice industry of British Guiana, now of the annual value of about £218,000, and the cultivation of rubber trees in British Guiana, Trinidad, and Tobago; also to the prospects of extending the Jamaica tobacco industry and of the preparation of cassava starch on a commercial scale.

In conclusion, Sir Daniel Morris referred to the future of the Imperial Department of Agriculture and the decision arrived at by the Home Government to continue the grant to a moderate extent for a further period of five years. Progressive contributions by the colonies would be necessary if it was proposed to continue the work on the present lines ; further, an understanding might be arrived at as to the practicability of establishing a central authority in agriculture for the whole of the West Indies.

A vote of thanks to the President for his address was proposed by his Grace the Archbishop of the West Indies, who expressed his gratification at the change that had taken place in the mental attitude towards agriculture in these colonies. The Imperial Department of Agriculture had, he said, brought about an identity of feeling as regards the value of improvement and the necessity of promoting industries by dealing with them in a manner at once practical and scientific. The resolution was seconded by the Hon. B. Howell Jones (British Guiana), who stated that the Imperial Department of Agriculture had grown into an organization of vast importance and of great necessity to these colonies. In acknowledging the vote of thanks, Sir Daniel Morris referred to the valuable and loyal services rendered by Dr. Francis Watts, C.M.G., Mr. J. R. Bovell, F.L.S., and the other officers of the Department. The programme* it was proposed to follow was explained, and an adjournment took place for luncheon.

On re-assembling at 2.45, an address of Loyalty to the Throne was moved by the Hon. F. J. Clarke and seconded by Hon. B. Howell Jones. An address to Lord Elgin, the Secretary of State for the Colonies, expressing thanks for the extension of the grant to the Department of Agriculture, was also passed.

Mr. H. H. Cousins then read a paper on the sugar cane seedlings in Jamaica. He stated that D. 95 had been found very suitable for light soils where there was irrigation. B. 147 had not given the results expected from it, but in Trelawny, where they were subject to droughts, it had proved a valuable drought-resisting cane. B. 208 had given excellent results, and planters were much pleased with it.

Dr. Watts read a paper on the results of recent experiments with seedling and other canes in the Leeward Islands. The introduction of varieties, he said, was consequent on the disease attacking the Bourbon so that the crop fell from an average of 17,000 tons to 7,500. Other varieties than Bourbon were planted now, and diseases caused no anxiety, which he somewhat regretted, as, unless there was watchfulness, disease might come upon them unawares. The interest in the varieties now gravitated towards the production of the richest sugar yielding plant. The new varieties had, in a general way, been completely substituted for the Bourbon in the Leeward Islands. But there were still 190 acres planted in Bourbon out of a total 9,000 acres. White Transparent was regarded as a new variety when first introduced, but in a few years that too

* The remainder of this article is re-printed from the "Barbados Advocate."

would give place to other varieties. In St. Kitts the value of the industry was over £120,000 a year, and but for the varieties the industry would have been extinguished.

In reply to a question, Dr. Watts stated that in no instance had the Bourbon been brought to maturity in St. Kitts since the disease had attacked it.

Asked whether some seedlings were not also subject to disease Dr. Watts replied in the affirmative, but pointed out that those which proved unsatisfactory could easily be discarded.

Mr. O'Neale asked if there was any decrease in the cane crop planted after cotton.

Dr. Watts said, on the contrary, there was an increase.

The President said it had recently been stated in the *Agricultural News* that no apparent difference was noticed as a result, but an increased amount of manure was necessary. In St. Kitts they were quite satisfied they could grow cotton as a rotation crop.

In reply to Mr. Howell Jones, Dr. Watts said the substitution of new canes should never be made on a wholesale scale until they were satisfied that the variety was immune from disease. The changes were to be carried on cautiously and not suddenly, or in a violent and drastic way. The extension of varieties should be entered on not in a spasmodic effort as the result of a panic, but as an integral part of a planter's work.

Mr. Bovell mentioned that three seedlings had remained free from disease over several years now.

Mr. Bovell next read a paper on experiments with seedlings in Barbados. The first experiments in seedling production in the Empire were started in Barbados in 1888, and the experiments had been continued and brought up to date in 1905. The experiments comprised manurial tests and raising new seedlings; also the increase of saccharose in seedlings. So far they were dealing with 6,759 new seedlings, and 95 of these were considered good enough to recommend to the planters. Whilst Mr. Bovell was reading his paper the earthquake occurred, and the proceedings were brought to an abrupt close by that tragic event.

The Conference was resumed on board the Port Kingston on Saturday morning, whilst on the way to Barbados. All the delegates from the other colonies and Sir Alfred Jones and the honorary members among his party were present.

Mr. J. R. Bovell gave a *resumé* of the position of the cotton industry in Barbados. The industry, he said, had proved remunerative, and had extended rapidly. In a few years it had grown from 16 acres to 5,000 acres, The increase was well illustrated at Stirling plantation. In 1904 the owner had planted 34 acres, in 1905 he had put in 56 acres and in 1906, 90 acres.

Mr. F. J. Clarke referred to the formation of the Cotton Company to buy cotton from growers, and explained the methods adopted to secure careful and clean picking by the labourers in the fields. The present crop at Barbados had proved a failure in part. The bolls had fallen in dry weather, and the heavy rains had caused mildew. Diseases had appeared; but he thought if all the planters had been alive to the necessity of treatment at once they would have kept the worms under. The Paris green had been washed off by the rains, and this discouraged many people from using it as freely as they might otherwise have done. Those were discouraging conditions, but, on the other hand, prices had risen.

Mr. G. Carrington said he used to plant cotton sixteen years ago, and his plan was for it to come into bearing in February. He still thought this was what should be aimed at. November and December were the wet months in Barbados, and he did not think they should bring their cotton forward to be picked in those months. The best fields now growing in the island had been planted in October.

The President observed that no hard and fast lines had been laid down by the Department. They might adopt early or late planting as suited to local circumstances. They were still experimenting. October was a late month. Of course, if they had regular seasons the matter would be more easily dealt with. The object to be kept in view, was, as far as possible, to adopt cotton as a rotation crop on sugar estates.

Sir Alfred Jones enquired if the cotton growers in Barbados required advances to enable them to carry on cultivation.

Mr. Clarke explained the working of the Plantations in Aid Act, by which the £80,000 granted to Barbados to aid in tiding over the period until the Brussels Convention came into force, was used for financing estates generally. The Commissioners working this grant had not made a single bad debt since the Act was passed.

Mr. Pearson thought the grant had been made purely to aid in sugar cultivation.

Mr. Jesse Collings said he remembered the debate perfectly, and the grant was asked for and made for the general regeneration of the islands rather than for any specific industry.

Mr. Clarke said it was not as if they had a lot of new men coming in and taking up the land to establish a new industry and oust sugar cane cultivation. The same planters were going on as before. Cotton, moreover, was a subsidiary industry, and they aimed at making it a rotation crop.

Mr. Jesse Collings considered Mr. Clarke's explanation perfectly sound: and Sir Thomas Hughes and Mr. Henniker Heaton agreed.

Dr. Watts gave a summary of the results of cotton growing in the Leeward Islands. The report was favourable on the whole, although the seasons this year had been against the planters. He mentioned that in some of the smaller islands, especially in Anguilla, the introduction of cotton growing had changed the habits of the people, and instead of subsisting on root crops and raising a little stock they were building up a regular industry and an export trade.

Sir Daniel Morris, dealing with the cotton industry in St. Vincent, said that Island had suffered badly by the hurricane of 1898, and it had been further thrown back by the eruption of 1902. Soon after he cotton industry was started there, and in 1902-3 they exported 474 lbs. cotton. In 1904-5 they exported six times as much, and in 1906-7 they had exported 8,000 lbs. The area in 1904 in cotton was 1,500 acres, but in 1905 it fell back to 800 acres. But as he had mentioned, they had as a result of better cultivation a larger return from the smaller area. In 1906-7 the area went up again to 1,500 acres, and the prices that year were the best obtained, viz., eighteen pence. They had had excessive rains this season and the yield of lint was low in consequence. As regards the small cultivators in the several colonies, the President went on to explain that whilst an endeavour was being made to instruct them in cotton growing, they were not advised to go in for the industry, on any scale, as if they had a couple of bad seasons it would mean ruin to them, whilst the plantation owner would be better able to bear a loss. There was fear of repeating the lesson taught by the hurricane in Jamaica in 1903. Every small owner had put his land in bananas, and when the hurricane came, his loss was total and complete, and he had no other crops to fall back on. Hence they did not encourage the small owner to go in for cotton before he fully and clearly understood the risk he was running. They sought to begin at the top and teach the big land owner first. In that way the knowledge would be more quickly acquired and more generally spread. At the same time they did not discourage the small man. In Nevis, for instance, he found the other day that some 350 small growers had put in cotton, and there was great risk of their losing their crop through lack of knowledge. He at once telegraphed for an expert to enable them to save their crops, and this had been successful.

Sir Alfred Jones said he was very pleased with the statements that had been made, and especially with Mr. Clarke's explanation of the financial situation in Barbados. He thought that much was due to Mr. Chamberlain for that satisfactory state of affairs. He was certain that if the West Indies would only grasp the fact, they had the means of great prosperity before them. They would grow cotton and they could make money out of it. There was no possible doubt about that. As regards the company formed on the voyage out to work one of Lord Dudley's estates in Jamaica, operations would be begun at once, and would be pushed on. As regards the present expedition, he intended, all being well, to bring out a far greater expedition, next year. He was not going to give up the West Indies.

After some further remarks by the President the Conference closed.

RUBBER.

I.—RUBBER AT THE BRITISH ASSOCIATION.

YORK MEETING, 1906.

Extracts from the Address to the Section of Chemistry and Agricultural Science by PROF. WYNDHAM DUNSTAN, M.A., &c. President of the Section,

There is no more important group of questions demanding attention from the chemist at the present time than those connected with the production of india rubber or caoutchouc. An enormous increase in the demand for india rubber has taken place in the last few years, and last year the production was not less than 60,000 tons. Until recently the supply of rubber came chiefly from two sources—the forests of Brazil, which contain the tree known as *Hevea brasiliensis,* furnishing the Para rubber of commerce which commands the highest price, and the forests of Africa, where climbing plants, generally of the Landolphia class, also furnish rubber. The increased demand for caoutchouc has led to the extensive planting of the Para rubber tree, especially in Ceylon and in the Federated Malay States. Systematic cultivation and improved methods of preparation are responsible for the fact that the product of the cultivated tree, which begins to furnish satisfactory rubber when six or seven years old, is now commanding a higher price than the product of the wild tree in Brazil. It is estimated that within the next seven years the exports of cultivated india rubber from Ceylon and the Federated Malay States will reach between ten and fifteen million pounds annually, and that after fifteen years they may exceed the exports of the so-called wild rubber from Brazil.

The services which chemistry can render to the elucidation of the problems of rubber production and utilisation are very numerous. Methods of treatment depending on a knowledge of the other constituents of the latex have led to the production of rubber in a purer condition. Much still remains to be elucidated by chemical means as to the nature of the remarkable coagulation of the latex, As is well known, the latex is a watery fluid resembling milk in appearance which contains the rubber, or, as I think more probable, the immediate precursor of rubber, together with proteids and other minor constituents. The constituent furnishing rubber is in suspension, and rises like cream when the latex is at rest. On the addition of an acid, or sometimes of alkali, or even on mere exposure, coagulation takes place and the rubber separates as a solid, the other constituents for the most part remaining dissolved in the aqueous liquid or 'serum.' The first view taken of the nature of the coagulation process was that, like the coagulation of milk by acids, it is dependent upon a process of proteid coagulation, the separated proteids carrying down the rubber during precipitation.

This explanation cannot, however, be considered complete by the chemist, and there are peculiarities connected with the coagulation of the latex which are opposed to the view that it is wholly explained by the coagulation of the associated proteids. The experimental investigation of the question on the chemical side is beset with many difficulties which are increased if access cannot be had to fresh latex. A number of experiments were made at the Imperial Institute with latex forwarded from India. The difficulties contended with in preventing coagulation during transit were great, but in the case of the latex derived from certain plants these were to some extent surmounted, and the results obtained, especially with reference to the behaviour of certain solvents towards the latex, led to the conclusion that 'coagulation' can take place after removal of the proteids, and that in all probability it is the result of the polymerisation of a liquid which is held in suspension in the latex and on polymerisation changes into the solid colloid which we know as caoutchouc. Weber, by experiments conducted in South America with fresh latex, arrived at a similar conclusion, which later workers have confirmed. Although the nature of the process is not yet completely elucidated, there is little room for doubt that the coagulation is due to the 'condensation' or polymerisation of a liquid contained in the latex. For the chemist the important question remains as to the nature of this liquid from which caoutchouc is formed.

The chemical nature of caoutchouc is a subject which has attracted the attention of distinguished chemists from the middle of the eighteenth century, among them being Faraday, Liebig, and Dalton. Faraday was the first to examine the constituents of the latex of *Hevea brasiliensis.* It is only in recent years that our knowledge of the constitution of organic compounds, and especially of the terpene group, has rendered it possible to make any great advance. It is interesting to record that Greville Williams, in 1860, made most important contributions to this subject. He identified a new hydrocarbon, isoprene, as a decomposition product of caoutchouc, and recognised its polymeric relation to caoutchouc. . . . .

There are strong arguments for the view that the constitution of the parent substance present in the latex is nearly related to that of isoprene. . .

To Wallach and also to Tilden is due the further important observation that when isoprene prepared from oil of turpentine is kept for some time, it gradually passes into a substance having all the characteristic properties of caoutchouc.

I have very briefly drawn attention to the present position of our knowledge of the chemistry of caoutchouc in illustration of the interest which attaches to the examination of vegetable products, and also because of the immense importance of the problem from the practical and commercial standpoint. Chemistry in this case holds the premier position in reference to this subject, and to a large extent may be said to hold the key to the future of the rubber industry in all its phases. The discovery of better methods of coagulation, preparation, and purification will be effected through chemical investigation, as will also the determination of the manner of utilising the various other plants which furnish rubber-like latices. That the physical properties of raw rubber, on which its technical value depends, are to be correlated with the chemical composition of the material there can be no doubt. The chemical analysis of raw rubber, as at present conducted, is, however, not always to be taken by itself as a trustworthy criterion of quality, and more refined processes of analysis are now needed. Although the finest caoutchouc for technical purposes is only yielded by some half-dozen plants, under whose names these varieties of caoutchouc pass, there can scarcely be a doubt that the elastic substance in each case possesses a very similar, if not identical, chemical structure. Nearly all the latices and similar fluids furnished by plants contain more or less caoutchouc. Even opium, which is the dried juice of the capsule of the poppy, contains caoutchouc, whilst the opium yielded by certain Indian species contains a notable proportion. Chemistry must determine the means by which caoutchouc can best be separated from these relatively poor latices. In view of the increasing production of the nearly pure caoutchouc which is furnished by *Hevea brasiliensis, Funtumia elastica, Castilloa elastica, Ficus elastica,* and a few other plants which occur or can be cultivated in several of our tropical possessions, the question is not a pressing one at the moment.

Moreover, it cannot be doubted that chemical science will sooner or later be able to take a definite step towards the production of rubber by artificial means.

The production of caoutchouc by chemical means has, indeed, virtually been accomplished in its formation from isoprene. The exact nature of this change has still to be determined. When this has been done it will only remain to cheapen the cost of production to make the manufacture of synthetic rubber a purely practical problem. I should be the last to discourage the great extension of rubber planting which is now taking place. It is warranted by the present demand for the material. It has also to be remembered that the actual cost of producing cultivated raw rubber, which is at present about one shilling per pound, will probably be reduced, and the market price of rubber may eventually be so considerably lowered that, as with quinine, the synthetic production could not be profitably carried on. That is a question which involves many factors at present unknown, and only time can decide. Chemists may, however, confidently predict that before the British Association again meets at York the synthetic production of rubber will be a fully accomplished fact.

As I have said, our science is concerned with nearly every problem connected with the great rubber industry, and in concluding these few remarks I may allude to the production of vulcanised rubber depending on the formation of additive compounds of the hydrocarbon with sulphur. In this connection I should mention the recent experiments of Mr. Bamber in Ceylon, which appear to show that vulcanisation may be accomplished by acting on the uncoagulated latex with chloride of sulphur. If this proves to be practicable, it may mean the transference to the tropics of the subsidiary industry of vulcanisation, which is at present carried on in Europe.

II.

Notes on these Extracts by H. N. RIDLEY, M.A., F.L.S., Director of Botanic Gardens, Straits Settlements.*

There are two main points in the paper, one that chemistry

*Agricultura Bulletin of the Straits & Federated Malay States, Vol. 10, Oct. 1906 p. 372.

may, ere long, be able to utilize the small quantities of caoutchouc known to occur in other plants beside the well-known four or five important rubber plants ; and second, that it may be possible to make rubber synthetically.

For the first point to be one of real practical importance it would be necessary to find a plant which produces latex containing rubber which can be more easily grown and produces so much latex that even the small quantity of caoutchouc it contains will be sufficient for it to compete with say *Hevea brasiliensis*. Thus, say a latex contains $\frac{1}{8}$ the amount of caoutchouc produced by *Hevea*, the plant would have to produce more than 8 times the amount of latex to compete, as the extraction of the rubber from this thin latex would obviously cost more than from the richer latex. It is hardly probable that this would be discovered now. Still other latices might be utilized in a small way, such as those of the Jack tree, which might possibly pay for extraction in some parts of the world. But a discovery of this nature, *i.e.*, of a method of utilizing the sticky immature rubber, or viscin as it is commonly called, would be of some importance to the Para-rubber planter, for by it he would be able to utilize the thin sticky rubber from leaves and twigs of his Para-trees and the tappings from the nursery beds, so that on the whole, any such discovery, almost certain to be made, would rather benefit him than injure his business.

Synthetic rubber has been the bogy of many would-be investors of rubber, and no question is more often asked than, is it likely that synthetic rubber will soon be invented, and the plantations ruined. As Professor Dunstan writes : "Rubber having all the qualities of a good caoutchouc has been made from isoprene, which has been prepared from oil of turpentine." It surely needs hardly any pointing out that the slow growing expensive turpentine trees, inhabitants of cold climates where labour is extremely costly, could not for a minute compete against the rapid growing Para rubber tree in a climate where labour is cheap, especially when from the *Hevea* we get the rubber fully prepared when the latex is drawn from the tree, whereas in the turpentine tree, after drawing off the turpentine, it has to be made into isoprene and then into rubber. Isoprene must be made far more cheaply than in this way to compete with Para rubber. It is certain that we shall be able to lower the cost of the production of rubber very considerably in the next few years, perhaps to little more than half its present cost. Can any substance be found from which isoprene or any other hydrocarbon convertible into rubber can be obtained and converted at a cheaper rate ? This is hardly probable.

The vulcanization of latex at which Mr. Bamber has been working, was a subject of discussion many years ago in the Straits. Its commercial practicability depends on the possibility of starting manufactories of rubber goods on a large scale in the rubber districts. It is notorious that there are practically no large manufactories in any part of the tropics. All or nearly all attempts at starting anything except strictly local manufactories even in the most suitable localities. have proved complete failures. The continuous work in one place does not suit the Oriental at all, least of all the Cingalese, Chinese and Malay, the workers of the rubber region in the East. Till the manufacturing classes of Europe can be so acclimatized, as to settle in the hot damp rubber regions, and without deterioration of character and stamina, populate the equatorial belt, it is not at all probable that any large manufactories of vulcanized goods will ever become practicable here.

III.—CASTILLOA RUBBER.

A. Cultivation *

The following information is abstracted from an article by Theodor F. Koschny, San Carlos, Costa Rica, which appeared in the *Tropenpflanzer* for December 1905. The references to the best variety for cultivation are of particular interest :

A short time ago only one species of the genus *Castilloa*, viz., *Castilloa elastica,* was presumed to yield marketable rubber. In July 1901, the writer distinguished a variety of this species under the suffix *alba.* The rubber from *Castilloa elastica*, var. *alba*, fetches from 10d. to 1s. more per lb. in Hamburg than that of *Castilloa elastica* var. *mexicana.* O. F. Cook has discovered several species of Castilloa on the Pacific side of Central America, all of which yield marketable rubber. H. Pittier has found another species, *Castilloa nicogana,* near the Gulf of Nicoga. *Castilloa costaricana,* which grows at high elevations south of 10° N., differs only in the leaves from *C. alba*; but it yields a very little rubber of a low quality. Unfortunately, it appears that all the plants sent first to south-east Asia and New Guinea were of this nearly valueless species. It is the one planted first in Java.

C. elastica, var. *mexicana,* was the species collected by Dr. Preuss for the German colonies. It produces a good quantity of rubber and its cultivation is remunerative, but the quality of the rubber is inferior to that of *C. alba.* The latter can replace the best Hevea rubber; the tree is more cheaply tapped than Hevea ; the preparation of the latex is simpler, and the returns are greater. Dr. C. O. Weber says in regard to his trials of this species : 'The rubber thus obtained is a product of a degree of purity, in which no rubber, not even the finest brands of Para, has ever been offered to the manufacturer.' The scrap rubber, when clean, is valued at the same price as the best Sernamby of Para.

Castilloa requires a certain amount of shade. It will not grow at all, of course, under the full shade of a forest. With too much shade it forms thin, tall, easily-broken stems which increase but slowly in thickness. But it is not a tree for the open. It grows very well in the open as long as the sap is watery ; but when it is older and taller the sun strikes on the unshaded trunk and warms the thick latex in the bark. This causes the death of many trees even without tapping. Experience has shown, again and again,

* From "Agricultural News," VI, 125.

that no unshaded plantation of Castilloas will stand heavy tapping for many years.

Up to the sixth year the plantation needs no shade. Two years later, if the plantation is not kept cleared, wild trees and bush will have grown high enough to shade the stems in a moist climate. If this plan is not adopted, or if it is prevented in places by long dry seasons, then shade trees should be previously planted. I have practised leaving forest trees standing singly when clearing the ground for a plantation. If two-fifths or three-fifths of the original forest trees are cleared away at first, the Castilloas grow well. After six years, no more cutting away of bush need be done.

From 1879-82 I planted *Castilloa alba* in open land and also between cacao, 8½ acres of each. Those in the open died without tapping or at the third tapping. Those in the forest or at the edge of the forest are alive today, and have been tapped every year. Castilloa requires perfectly permeable subsoil. Where the soil or sub-soil is not of this character, no Castilloas should be planted. Castilloa would not be attacked by the beetle borer if the tree was in health, and if such is the case, it is to be presumed that the sub-soil is impermeable and the tree unhealthy. Seedlings can be transplanted when very small with earth about their roots, or they can be transplanted at a year old if the tap-root is cut back to the woody part, all side roots cut off, and also the stem cut back to wood. Such a bare stick must be planted with the crown (from which the first new roots grow) ½ inch to ⅔ inch under the soil. If the crown is above the soil there is no growth.

The often-advised close planting of Castilloas and subsequent thinning is not usually to be recommended. Where land is cheap or where the wind may be strong, it should not be done. Close planting produces trees with long, weak trunks. After thinning, they are easily blown down. It is to be noticed that in tapping, the strong bast fibres, which help greatly to support the stem, are cut, and a tall tree is then easily broken down by wind.

B.—Tapping.*

Mr. J. Herber Foster, of Tula de los Tuxtlas, gives in the *Mexican Investor*, for January 5, 1907, his results in tapping Castilloa trees.

Mr. Foster shipped about 1,200lbs. of rubber from the Tula plantation in 1906. The trees averaged 20 to 25 inches around, just about the root enlargement, the largest ones ranging from 30 to 38 inches. He uses a Smith tapping knife and makes three V cuts about 20 inches apart, each reaching not quite round the tree, but leaving 5 inches uncut. A small cup is fixed at the apex of each, and the latex spooned down into it. The cups are emptied into a pail. There is no need of water to prevent coagulation. The cups are not left on the trees. After tapping twelve trees, and again after two or three hours, the workman returns and spoons out the cuts. At Tula the men tap all day, while at Soconusco the heat cheeks the flow in the afternoon.

* From "Agricultural News," VI. 125.

Each man has two 30 gallon barrels. The latex is washed through a fine sieve together with the washings of the cups, and the result of one day's work usually fills one barrel. The next morning the water is drawn off, as the creamy latex is on the top. The barrel is then half filled with fresh water, which is changed the same day. On the next morning all the water is drawn off, and the cream poured out into frames to dry in the sun. The frames are made of 1-inch by 2-inch strips, 5 feet long and 10 inches broad, and divided by cross pieces into 8-inch squares The bottom is made of cotton cloth. In ordinary weather, three to six days are required for drying. In 1905, the average price for Tula rubber and scrap was $1 gold per lb.

PINE-APPLE GROWING IN JAMAICA.

By George Loutrel Lucas.

Pine-apple growing as an industry has not proved successful in Jamaica to the majority who have undertaken the business although ideal conditions exist and shipping facilities are good.

Much capital has been lost and discouraging reports have been published far and wide condemning the business as being unprofitable, whereas Jamaica has had to suffer and be blamed for the ignorance and mistakes of so-called experts who have been sent to the island at good salaries by too confiding capitalists.

Jamaica is capable of growing the finest pine-apples in the world and whilst Cuba, the Bahama Islands, Florida and Porto Rico have for many years produced millions of splendid pine-apples which have yielded and are still yielding the growers substantial incomes and paying well on the investments Jamaica has had little but failure to show.

There is always some cause for failure of any kind and the reason for the miserable condition of the pine-apple business in Jamaica to-day can only be attributed to blind prejudice and egotism.

Other countries grow the only variety of pine-apple that has proved profitable whilst Jamaica has been wasting time, energy and money trying to grow those sorts that have never become popular with the consumer and never will.

Here we have the only reason for so many failures; neither soil, climate, location, money nor a knowledge of the ordinary rudiments of cultivation have been at fault and whilst the system and methods of growing pine-apples have been somewhat crude and could have been improved upon, cultural knowledge has been sufficient to produce good crops had these crops consisted of the proper kinds of fruit that could have been disposed of at a profit.

The Smooth Cayenne Pine-apple at one time became a fad in Florida and from that State it found its way to Jamaica where large sums were expended for plants only to end in failure and disappointment as it eventually did in Florida and to-day there is hardly a Smooth Cayenne Pine-apple grown outside of the Azores where it is cultivated under glass and other shelter, and where I am told each pine-apple costs one shilling to produce.

This variety is a watery, flavourless overgrown fruit with nothing to recommend it but its appearance and size; it is a shy bearer, poor shipper, produces few suckers and no slips; a pine-apple unsuited to field culture being delicate and subject to Wilt and other diseases.

The Ripley pine-apple, so highly thought of in Jamaica, is and has always been greatly over-rated and few outside of this island consider it worth growing as a general crop for profit and both the Smooth Cayenne and the Ripley pine-apple have been the rocks upon which the industry has been wrecked.

The Ripley pine-apple belongs to the Queen family of which there are several varieties; all of them can be readily distinguished by their distinct appearance having small eyes which penetrate deeply into the fruit causing much waste; fruit small and narrow in shape with a musky flavor which is an objection to the majority of consumers abroad; all varieties of the Queen family are of delicate constitution subject to Black Heart and Wilt, two diseases that have been found impossible to prevent or cure. In a field of Ripley pine-apple plants after the Wilt makes a start, no matter how small the affected area may be, it will in an incredibly short space of time spread over acres and in a few months will completely kill every plant no matter whether the plants be old or young, but this disease seldom allows the plants to become of any age before it completes its work of ruin.

Black Heart unlike the Wilt affects the fruit instead of the plants causing black spots in the soundest looking fruit which cannot be detected until the pine-apple is cut when it will be found worthless.

Leaving aside the diseases of the Ripley pine-apple, its shape, size and general appearance mitigate against it in the markets of the world; Canada and the United States both positively refuse to take it at any price, whilst England will take a few, the prices realized however, seldom covering expenses and freight.

The cause of repeated failure to make the pine-apple business a success in Jamaica can be attributed to prejudice and a persistency in ignoring the one profitable and marketable pine-apple. In spite of every warning by those who have some knowledge and who have made the growing of pine-apples a success added to the fact that 90 per cent. of all the pine-apples grown in the countries above mentioned consist of Red Spanish variety, no attempt has ever been made to grow this profitable fruit in Jamaica upon a commercial scale.

The Red Spanish pine-apple, whilst not perfect, is the only fruit that possesses such merit as to warrant other growers in placing their dependence in it, and has proved profitable to those who have cultivated it exclusively: it is a fruit of good appearance being globular with large shallow eyes, flesh white and firm, flavour sprightly and agreeable with the true pine-apple bouquet so sought after by the foreign consumer; this variety grows to a large size and makes an excellent appearance with its large crown or top;

a splendid shipper and the best seller that has been found of 53 varieties that have been tried and tested in the years gone by.

The writer has grown pine-apples for more than 23 years and continues to grow them in large quantities and whilst small lots of various sorts are grown for nursery purposes, the principal crops at Norbrook consist of Red Spanish which is the only pine-apple that is shipped abroad.

The Red Spanish plant is vigorous, free from disease and easy to grow and with proper cultivation will yield as high as 95 per cent of marketable fruit in 12 months after planting, and the fields will continue to yield profitable crops for 5 to 6 years, which no other variety will do.

In view of the foregoing facts it is unwise to grow for shipment any other variety of pine-apple but the Red Spanish. It must be borne in mind that the pine-apple grower is expected to supply the consuming public with what they are willing to pay for, and no matter how well the Ripley may be thought of in its native land, we cannot afford to bring sentiment into any business that is expected to pay a profit on the outlay. On the whole the pine-apple business in Jamaica has been most severely and unjustly condemned by those who were supposed to know something about agriculture, and, had they listened to reason, would not have left the island and published their failures far and near, blaming Jamaica for all their shortcomings, and intimidating those who might have felt inclined to invest their money in a business that if properly conducted, should to-day be one of Jamaica's principal industries.

COTTON.

I.—OBSERVATIONS ON THE PLANTING OF COTTON IN THE YEAR 1786.*

It is necessary, in the first place, for those who wish to plant cotton with advantage, to take the early part of the year for preparing the soil; which is best done by hoe-ploughing, or laying the ground in small ridges or potatoe hills, which prevents the soil throwing out a crop of weeds, and gives double vigour to the powers of vegetation, The months of May, June or July, are the best seasons in Jamaica for planting; and when the rain has penetrated the ground to the depth of twelve inches, there is every chance of succeeding in getting the plants so strong as to resist the dry season until the October rains come. I recommend immersing the seeds in water for twelve hours before planting them, as they may sooner come up and get strength, than by putting them in the ground in their dry state. The seeds so immersed separate, part sink and part swim; the heaviest are to be the best depended on. The distance of the plants should be three feet in the line, and eight feet separate between such lines. I find, when so close, the trees are better protected from the dry weather, the ground being sheltered by their foliage; something resembling the old style of cut

†Extract from the Jamaica Almanac for 1787.

fences. When the plants arrive at the height of sixteen inches, they are then to be topped; a dry day must be chosen for that purpose and about an inch of the uppermost part of the plant is lopped off, as well as of the principal branches. This operation produces a number of branches to protrude from the principal stem, and spreads the tree, without permitting it to run into high wood. At this time the cotton ought to be hilled up, and as strong a moulding given as will secure it in an erect situation. When the autumnal rains commence, it will be necessary to top all the trees that have grown above four feet in height and reduce them all to one elevation, permitting the branches that spread horizontally to enjoy that situation uninjured. Cotton should never be permitted to rise heigher than six feet, as the pods, in their green state, form a great weight, and are broken down, if too tall, by every breeze. Whenever the crop ends, cut all down within two feet of the ground, and treat the ratoon, in the autumn, in the same manner as before directed.

When the season for picking arrives, the whole attention ought to be directed to gathering it. Take none but what is fully open and dry, never intrude on the half opened pod. The wool should be pendant and in a state of complete separation; so taken, it saves the great labour of whipping, which is a tedious process and injures the seed. The wool should be laid under cover, in order to dry the seed. When brought to the gin, it should be exposed to the sun, as, the drier it is, the more easily will it pass the machine.

The gin, the great article of labour, ought to be so constructed as to give great effect to its mechanism. Three pair of rollers may be worked longitudinally with the same wheel; two negroes driving and three feeding such a gin, should clear one hundred and eighty pounds weight a day with ease.

When the caterpillar attacks the cotton in the early part of the year, they may be permitted to fly off unmolested but if they come in the season when the tree begins to blossom, they must be destroyed, or they will destroy the crop. If the land is clear, simply shaking them off the tree will be sufficient, as the ants will kindly take the part of the planter, and prevent their return. But if the ground is full of weeds, they must be killed as you take them. The red fly is a constant companion of the cotton in opening, but seldom does much mischief, except by soiling the wool.

When once cotton is established, a crop of corn may be always taken along with it, without injury. It should be great corn, if possible, as that is taken in before the tree begins to blossom.

II.—COTTON EXPORTED FROM THE WEST INDIES AND GUIANA IN 1799.

Extract from "History of the Negro Slave Trade" by ROBERT BISSET. Two Vols. London. 1805, pp. 342-343*

I have been at very great pains to learn the relative state and

*Communicated by H. E. Sir J. A. Swettenham.

amount of cotton wool, coming from India and Turkey, and consequently not raised by Negro labour; and the state and amount of cotton wool coming from America and the West Indies to Britain, and consequently raised by Negro labour. I have been enabled to procure the annexed official statement for one year; and find that both the amount and proportion still more extensively display the value and importance of Negro labour. The year in question was 1799.

In time of peace there were imported annually into Great Britain and Ireland from Bordeaux, Nantz, Havre-de-Grace, L'Orient, Marseilles, and Dunkirk, between thirty and forty thousand bags of cotton, that were grown in St. Domingo, Cayenne, Guadaloupe, Tobago, and Martinique; and a small quantity is brought from the Isle de Bourbon in the Indian ocean. From Amsterdam, Rotterdam, Middleburgh, and Flushing, in Holland and the sister provinces, are imported between twelve and fifteen thousand bags of cotton, the produce of Demerara, Essequibo, Berbice, Surinam, and other Dutch West India Settlements. From Denmark two or three thousand bags of cotton, the produce of the Island of St. Thomas, and a small quantity from the Danish East Indies are imported into Britain. From Spain, between six and eight thousand bales of cotton, the produce of the Caraccas, Cuba, and Porto Rico, are imported into Britain. All the cottons whatever, consumed in Europe—except what come from Turkey and the East Indies—are cultivated and raised by the labour of Negroes. The quantity of cottons imported into Britain and Ireland in the 210,231 bags, above-mentioned, at the common average of about two hundred pounds per bag, is upwards of forty-two millions: the proportion of the raw materials raised by Negro labour, to the raw materials not raised by Negro labour, is greatly above 7-eights, and not much under 8-ninths.

COTTONS IMPORTED, AND FROM WHENCE.

The under were not raised by Labour of Negroes.	*Carried by Ships.*	*No. of Bags.*
East Indies ...	British Ships	15,716
Turkey ...	do.	9,142
		24,858
The under are all raised by Labour of Negroes.		
Lisbon, grown in the Brazils—Sent to Lisbon in Portuguese ships, and from Lisbon to England in	do.	96,410
Oporto, grown in the Brazils—Sent to Oporto in Portuguese ships, and from Oporto to England in	do.	4,251

United States of America	...	American Ships	28,535
New Orleans	...	Part in British & part in American Ships	2,824
Demerara	...	British Ships	3,652
Essequibo	...	do.	1,946
Berbice	...	do.	1,875
Surinam	...	do.	2,596
Jamaica	...	do.	12,436
Bahamas	...	do.	4,728
Trinidad	...	do.	1,416
Tortola	...	do.	682
Tobago	...	do.	1,376
Antigua	...	do.	291
St. Vincent	...	do.	1,548
St. Lucia	...	do.	1,364
Grenada	...	do.	1,732
Barbados	...	do.	13,648
Dominica	...	do.	463
Martinique	...	do.	2,195
Montserrat	...	do.	126
St. Kitt's	...	do.	842
St. Thomas	...	do.	437
Total raised by the Labour of Negroes	..		185,373
Total not raised by the Labour of Negroes	...		24,858
Total imported during the War in the year 1799			210,231

REPORT ON WORK AT CINCHONA, JAMAICA, THE TROPICAL STATION OF THE NEW YORK BOTANICAL GARDEN.

By DR. FORREST SHREVE.*

To Dr. N. L. Britton, Director-in-Chief, New York Botanical Garden.

Sir,

Having been granted leave of absence during my tenure of the Bruce Fellowship in the Johns Hopkins University, I left Baltimore on October 13, 1905, for Jamaica, where I at once took up my residence at the tropical station of the Garden, at Cinchona, remaining until May.

The general plan of my work was to make a study of the physiological plant geography of the Blue Mountain region above an altitude of 4,500 ft., and the various lines of investigation which this embodied were carried on more or less concurrently. I made a digest of the old meteorological records for Cinchona, and other nearby points, in regard to air and soil temperature, humidity and rainfall. With these climatic data as a basis I then en-

* From Journal of the New York Botanical Garden, VII, No. 80, Aug. 1906.

deavoured to determine the exact departure from them of the conditions in a number of plant habitats varying in topographic position, exposure and altitude. To this end I secured weekly records with air and soil thermographs and with a hygrograph, and also made observations as to the percentage of cloudiness and fog, and took photometer readings of the intensity of light. The most salient features of the climate are the extreme constancy of the temperature, the height and constancy of the humidity, the prevalence of cloud and fog, and the large amount and frequency of rainfall.

Selecting certain characteristic trees and herbaceous plants I made a study of their rates of transpiration, using chiefly the method of weighings and the photometer method. The daily march of transpiration was determined by hourly readings, and simultaneous readings were taken of temperature and humidity and of evaporation as registered by a form of evaporimeter devised by Dr. B. R. Livingston. After thus determining the combined influence of natural conditions upon the daily cycle of transpiration in certain species, it was my plan to determine the influence in the same species of variations in heat, light and humidity operating separately, but I was able to carry out this plan only in part. The rates of transpiration showed a high degree of sensitiveness to changes in temperature and humidity, and under favouring conditions as to these factors and light some high rates were measured. However the extremely low rates which were found to accompany cloudiness and high humidity, together with the prevalence of these conditions, particularly on the northern slopes of the Blue Mountains, point to the annual total of transpiration being very low as compared with that in tropical lowland vegetation.

Measurements of the rate of growth of leaves in a number of trees, shrubs and herbaceous plants in the moist mountain forests indicated rates much lower than in tropical lowlands or in the temperate regions, this being true even of the renewing foliage of completely deciduous trees. A series of observations was begun on the periodicity of growth, leafing-out, leaf-fall and blooming, as well as on the duration of life of leaves in forest trees and shrubs but these observations require a longer continuous residence to be made of the fullest value.

I made observations and did some experimental work with regard to the significance of the wetting of leaves by rainfall and condensed moisture. Dripping points are but poorly developed in the native vegetation and the occurrence of epiphyceae was found to be independent of the character of the foliage. The wetting of the upper surface of leaves was found to reduce transpiration, but both direct and indirect evidence showed this to be due only in part to the cooling of the leaf.

Many interesting features were revealed by a study of the anatomy of the leaves of certain typical plants.

A field study of the habitats and local distribution of the filmy ferns was made, and supplemented by an investigation of their moisture relations, particularly the capacity of roots and leaves for water absorption, the capacity of leaves to avail themselves of atmospheric humidity, and the behaviour of chloroplasts in dry and in strongly illuminated leaves. Material preserved for a study of the anatomy of the leaves promises to show some interesting structures securing mechanical stability in these thin organs.

Notes were taken for the preparation of a descriptive account of the vegetation, with a particular view to correlating differences in various habitats with the ascertained differences in physical factors prevailing there. Differences in physiographic situation were found to be at the bottom of the differences in physical factors, and to be of more importance than altitude (above 4,500 feet) in determining both the floristic and vegetative character of the forest.

SOME DISEASES OF PALMS.*

By E. J. BUTLER, M.B., F.L.S.

Imperial Mycologist, Agricultural Research Institute, Pusa.

Fungus diseases of palms are rare, a fortunate matter if we consider the extraordinary value of these trees to the people of tropical countries. A few have appeared in India in recent years, each apparently confined to a particular part of the country and while due to different causes, agreeing in their general effects.

KOLE ROGA DISEASE OF BETEL PALMS.

A disease of betel-nut palms (*Areca Catechu*) has been known in the Malnad districts of Mysore particularly near Koppa for many years. It is locally termed " kole roga" or black rot. Up to the present it has not been found elsewhere and, as it does not appear to have extended much during the time it has been observed, it is probably favoured by the special climatic conditions of the locality where it occurs.

The first symptom of the disease appears at the time of flowering. A number of the flowers fall without setting fruits, and their stalks blacken and putrefy. The rot gradually extends along the inflorescences and affects the stalks on which nuts are forming, causing the latter to drop while immature. Very often the damage does not stop here. The flower stalk arises from the axil of the lowest leaf and, therefore, leads directly to the base of the swollen green part at the top of the stem. This green portion consists of a number of leaf sheaths, which clasp the young growing end of the palm, forming a thick protective covering to the growing point. The lowest of these sheaths becomes affected near the point of origin of the flower stalk, and a patch of rot makes its appearance at this point. The sheaths next underlying the first are then attacked and, since the internal parts are softer than those outside, the rot spreads with increasing rapidity as it approaches the apical bud. When the growing point in the centre

*From " *The Agricultural Journal of India*," Vol. I., Part IV., Oct. 1906.

of the bud is reached, it also is destroyed, and the whole head withers and falls off. Not alone, therefore, is the crop lost, but the whole tree is killed, the damage caused in the affected districts being very heavy.

In the diseased spots on the leaf sheaths and also on the withered fruit stalks, a fungus of the genns *Phytophthora* is found. There is little doubt that this is the cause of the disease. The few species of *Phytopthora* are all virulent parasites, and though the well-known *Phytophthora infestans*, the cause of the potato disease, has been grown on dead substances, its development is much less vigorous than on its living host. The betel palm *Phytophthora* is evidently, from its position, anatomical characters and the enormous quantity of spores which it produces, an active parasite.

The fungus consists of a mycelium or vegetative part living within the tissues of the palm and extending out on to the surface, and of sporangia or reproductive bodies formed exclusively on the external filaments of the mycelium. The internal part consists of colourless threads lying between the cells. Here and there these filaments reach to the surface and grow out into short branched threads. At the ends of these, and also sometimes on short stalks set laterally, the sporangia are produced. They are pear-shaped bodies with the broad end attachcd to the stalk, from which they fall easily. In water they germinate rapidly, giving rise each to a dozen or more tiny swimming spores, the zoospores. These swim off in all directions and after a time come to rest, get quite round and in their turn germinate by putting out a thread. It is by means of these sporangia and zoospores that the disease is propagated.

Since for their proper germination *Phytophthora* sporangia require to fall into water, most if not all the diseases due to these fungi are closely dependent on conditions of moisture and rainfall. For the spread of the betel-nut disease which appear to begin on the flower and fruit stalks, it is necessary that the moisture conditions should be favourable during the time of setting of the fruit. The heavy monsoon rains in these parts of Mysore begin in June and last until the end of August or September. The following observations may serve to explain the increase in severity of the disease in recent years, and also its restriction to a single area.

When the disease first made its appearance, some thirty or forty years ago, it was customary to harvest the nuts in November or December. For the last twenty years the harvest has become earlier, being sometimes collected as soon as July or August. This indicates a change in the habit of the tree, due either to a different method of treatment or the introduction of an earlier variety. The effect of this is to expose the fruit stalks to infection at a time when the moisture conditions are most favourable for its growth. In some gardens the harvest is still gathered in December, and in these I was informed that there is little complaint of loss from the disease. In Mudigere and adjoining parts of Mysore the harvest is ordinarily in December and

January, and the disease does not appear to have obtained a hold in this district. Similarly, though the whole of the country approaching the ghats obtains a very heavy rainfall, the harvest is later than at Koppa in most places, and here also I was informed disease does not appear. The cultivators themselves are aware of the deleterious effects of rainfall during the maturation of the nuts. At Koppa they have devised a remarkable method of protecting the bunches during the monsoon. Before the commencement of the rains each bunch is covered with a thatch made of the leaves or expanded flower stalks of the palm. It is stated that considerable benefit has resulted from this practice.

In endeavouring to check the disease, two objects should be aimed at. The first is to revert, if possible, to the late harvested crop of former years. This may be possible by altering the methods of cultivation now in use in the betel gardens. To ascertain if this is possible, a much fuller enquiry is necessary than I was able to undertake. It may be that by a less forcing treatment the palms are in many places trenched to a depth of six inches, the trench filled with cattle manure, and a mulch of leaves, new soil, &c., applied round their bases--a later crop would be obtained. Experiments are necessary to settle this point and also the degree to which it will be really effective in preventing the spread of the disease. Search should also be made for later varieties of betel palm, if such exist.

The other and more efficient method of prevention is the improvement of the covers used for the bunches. The covers now in use are far from satisfactory. They dry and crack in fine weather, and during long continued rain rot and fall to pieces. They are tied over the bunches as soon as the rains begin, and no disadvantage appears to result from the shade which they cause. But leaky covers are likely to be worse than none at all, for they check evaporation and ventilation, and preserve a moist atmosphere around the bunches which is bound to favour the growth of the fungus. The use of tin covers would, I believe, not be beyond the means of the well-to-do owners of gardens, and would be far more effective than the palm ones. An educated native of Koppa informed me that he had made experiments with zinc covers with very good results, the covered nuts remaining quite sound while those uncovered rotted. The tin covers would last for several years and, if made on a sufficiently large scale, would not cost a sum beyond the reach of the ordinary betel grower, and would repay their cost in a single year in all probability. It is well worth while endeavouring to introduce the use of these tin covers in the affected districts as a substitute for the leaf ones.

BETEL NUT PLAGUE IN SYLHET.

The cultivation of the betel palm is one of the chief industries of many tracts in Sylhet, and a serious disease would be expected to attract a considerable amount of attention. It is, however, a curious instance of the fatalism which is such a bar in India to the application of certain sorts of scientific agricultural practice, that the disease here mentioned should scarcely have been heard of until a couple of years ago. As a matter of fact, enormous numbers of palms are dying over a large extent of country, and the cultivators themselves are in a state of passive despair in face of a calamity which they cannot understand.

The extent of the area affected is quite unknown, but it includes almost if not quite the whole of North Sylhet. I have seen the disease from Chhatak to Badarpur in greater or less severity, but there are centres where the loss is very much more serious than elsewhere. One of these is Kanairghat which I visited in May 1905. In Kanairghat and the surrounding villages there are hundreds of acres of betel gardens, and the actual loss suffered amounts in many cases to more than seventy-five rupees an acre annually, while some gardens were seen in which fifteen-sixteenths of the trees had been killed.

The symptoms are quite characteristic and are readily recognized by the villagers. As in the Mysore disease, one of the earliest signs is a dropping of the nuts. Almost the whole produce of the palm may be lost in this way at an early stage in the disease. Very soon the swollen green part at the top of the stem, below the leafy head, is found to be diminishing in size, and quite the most striking symptom is this change from the graceful curved swelling of the coverings of the terminal bud to an almost straight-sided cone at the top of the tree. Withering of the outer leaves accompanies this change, leaf after leaf withering until the whole head dries up and falls off. The final appearance is just the same as in "kole roga."

In the early stages of the disease the leaves and terminal bud show no signs of rotting, and even after the outer leaves begin to wither and the head to shrink, the conditions resemble those which would be caused by drought or some general disturbance, and not by a local disease at the crown of the palm. No trace of any parasite fungus can be found in the earlier stages at the top of the tree. The stem is generally healthy. Below ground, however, matters are different. Here there is invariably a rot, either of the roots or of the below-ground part of the stem, even in very early cases. A large number of trees of all ages were dug out and examined, with the result that the presence of a root disease was placed beyond doubt. In some cases the base of the stem itself remained healthy, while all or most of the feeding roots were destroyed. In others the rot was more visible in the stem. The characters of the rot were similar in all cases, the wood being turned brown and filled with the mycelium of a fungus. Usually this fungus was found to have invaded the ends of the roots and to have progressed along these into the stem, killing the tissues as it advanced. But whether it originates in the roots or appears first in the tissues of the "collar," the effects are always the same and are quite sufficient to account for the death of the trees.

A number of root-destroying fungi are known in different parts of the world. In most cases their attack is more or less similar to the above. The Himalayan deodar disease, due to *Fomes* *annosus*, attacks at first the lateral roots and works its way into the stem, where it sets up a destructive rot, eventually killing the tree. Similarly the Rosellinias, of which several different species are responsible for the disease known as "stump rot," which is so common in tea and coffee estates, act in much the same manner. In all, from the position of the attack, remedial measures are extremely difficult, though the fungus may be prevented if taken in time from spreading to adjoining trees. The case which has been most fully tested is "stump rot." Several outbreaks of this have been checked on the writer's recommendation by trenches carried round the diseased patch in the earlier stages. The trenches were about two feet deep and a foot broad and were carried well outside the ground which the diseased roots might be expected to occupy. The trees inside the trench were pulled up and burnt, the ground being levelled and allowed to remain fallow for over a year. No new cases occurred outside the trench, though where this treatment is not adopted the diseased patch continues to expand almost indefinitely. Similar results have been obtained in Ceylon and elsewhere.

The following observation suggests that the same treatment may be successful in checking the betel-palm root disease. In a village near Kanairghat, I visited a very large garden in which over fifty per cent. of the palms were dead or dying. One corner of this was found almost entirely free from the disease. This was separated from the rest by a ditch which cut off sharply the diseased from the healthy portion. Everything appeared to indicate that the salvation of this part of the garden was due to the presence of the ditch.

To be effective, trenching must be undertaken as soon as the first disease appears in a garden. The trench should be two feet deep, about a foot broad and drained so as to prevent water accumulating in it. It should entirely surround and cut off the first affected palms. It is unusual for the whole of a garden to be attacked simultaneously. Generally, one or a few trees, are first affected, the disease spreading from these. Though it is probable that a part of the spreading is due to spores, infected soil or something of the sort being conveyed through the air or on the feet of the cultivators, the main infection occurs through the ground. Very few known fungi travel through the subsoil, most living in the upper layers and, where parasitic, attacking the superficial roots only. Hence a gap in the soil two feet deep is amply sufficient to stop this progress. But while the mycelium cannot gain access through the air, it probably can through stagnant water and certainly through dead leaves or debris, should any be allowed to lie in the trench. Hence it is absolutely necessary to keep the latter clean aud to drain off any standing water which may lodge in it. Should it be desired to utilise the ground inside the trench for replanting at an early period, the diseased palms should be cut down and their roots dug out and the ground turned over at frequent intervals for a year. This by itself is frequently sufficient to destroy the last traces of a parasitic fungus in the soil, but the process may often be shortened by adding lime. When the palms have been removed, a crop of plantains or other garden produce can be immediately grown with safety, as the disease does not spread to any of the common crops seen. After a year, if treated as above, betel palms may be transplanted to the infected place and will probably escape attack.

As regards the identity of the fungus, little can be said. From the presence of what are known as "clamp-connections" in the mycelium, it is probably one the of "higher" fungi—toadstools, bracket fungi or their allies. One such was found very frequently on the base of the stem of dead trees and has been identified as *Fomes lucidus*, a common tropical fungus, which there is considerable reason to suspect of parasitism on trees. But it is quite impossible to speak with any degree of certainty, and the actual working out of the cause of the disease would probably occupy a mycologist for many months. Enough has been said above to make it clear that the disease is a root rot and that there is evidence of its spread chiefly through the soil: and this being so, the treatment must follow the lines above suggested, direct cure being out of the question.

DISEASE OF PALMYRA AND OTHER PALMS IN GODAVARI.

It was stated in 1904 that a disease was ravaging the palmyra palm (*Borassus flabellifer*) plantations which are such a feature of the landscape in the Godaoari Delta. Next year it was reported that coco-nut palms were also being attacked, and the danger which might arise if such a disease spread to the rich palm-growing districts of South India was at once apparent.

The disease is said to have been noticed as far back as 1897 It has, however, only attracted attention by its extension withi. the past two or three years. It is said to have been seen first in Addunkivarilanka, an island in the north channel of the Godavari. From here it spread to the Amalpuram taluk on the southern bank and to the Ramachandrapuram taluk on the northern bank. It is now found in an area on both sides of the northern channel, occupying the whole of the Amalpuram taluk except the swampy district towards the sea, while on the Ramachandrapuram side it has reached Anaparti, about twelve miles from the river. Along the banks it extends some thirty miles, from the vicinity of the French settlement of Yanam to Madiki and Lolla. As in most other cases of infectious disease, it does not occupy an absolutely continuous area. Some villages have escaped though surrounded by diseased localities, and in some directions extension has progressed much more than in others. Thus the disease has been known at Polanka for six or eight years, and a mile or two to the east the palms are dead in great numbers; yet another mile along the canal not a single case was seen in thousands of palms visible from the banks. It may, however, be said in a general way, that in a circle from the centre at Addunkivarilanka where it is said to have started, with a radius of fourteen miles, most of the villages are affected. In the portion of the Coconada taluk towards the river, some twenty-five villages have reported the presence of the disease.

In the early period of the epidemic, the opinion was held by many of the local officials and prominent landholders that insects particularly a large (cockchafer) grub which is common enough in diseased trees, were the cause of death. But it is certain that they have nothing to do with it, for the whole nature of the disease is opposed to such a view, and a number of trees in the early stages were examined without finding the grub. The sharp limitation of the affected locality such as is found, for instance, near Yanam and Kolanka, joined to the slow spread through an almost continuous area, shows an infection by some germ incapable of rapid transmission. Most of the persons with whom I discussed the disease had already given up the idea that it is due to insects.

The extent of the damage can only very roughly be estimated. Along the Amalpur east bank canal seventy-six per cent. of one hundred and thirty consecutively counted palms were dead. This was a very bad place. In a similar line near Kolanka thirty per cent. were dead. Elsewhere every proportion down to few or no dead trees was seen. Possibly about ten per cent. of the palmyra palms of the above mentioned area have been killed. The trees are said to be worth from one to two rupees per annum, and the loss already sustained, though much less than that due to the Sylhet betel palm plague, must run into lakhs.

The most serious aspect of the matter is the fact that coco-nut palms are undoubtedly subject to infection. In Ramachandrapuram taluka few cases only were seen, but in Amalpuram they are numerous, though fewer than in the palmyra. This is perhaps due to their hardier tissues which oppose a barrier to infection. In one locality some two hundred dead coco-nut trees were seen; elsewhere only a dozen or two. The danger is that the disease may increase in virulence in regard to coco-nut palms if allowed to rage unchecked, and this is the most urgent reason why prompt measures to stamp it out are called for. A few betel palms were found attacked apparently by the same disease, but the cases were too far gone for satisfactory examination.

As in the other palm diseases above described, the symptoms are such that it can be recognised fairly easily. Most of the proprietors were able to point out even the early cases, their statements being checked by cutting down a number of the palms indicated, The earliest sign is an alteration in colour of one of the leaves. usually one of those recently expanded towards the centre of the bud. This turns white and soon afterwards commences to wither. Other leaves are attacked in turn, the heart of the bud is reached and the whole top withers and falls off, the last stage often being reached only after a considerable time. In coco-nut palms the same general course is followed, but here if the nuts have been formed before the attack becomes severe, they are often dropped prematurely. No new nuts are formed once the characteristic symptoms show. No case of absolute recovery was met with, but in one or two it was said that the disease had been checked for a time and had then re-commenced.

The whole of the stem and root system is perfectly healthy up to a late stage in the disease. With the crown, however the case is otherwise. The expanded parts of the leaves are, it is true, unaltered and apparently healthy until withering sets in. In the leaf sheaths, however, the signs of disease are unmistakeable. These sheaths are a remarkable feature of the structure of most palms. They form a series of twenty or thirty tube-like layers closely applied one under another so as to form a funnel. The actual top of the stem or apical bud is sunk in the centre of this funnel and protected by it, a protection which is a necessary one, for it is the most vulnerable part of the tree and death follows its destruction. To reach the apical bud a parasite must penetrate these layers. This is what actually happens.

The leaf sheaths of all diseased trees are marked by irregular, sunken spots in greater or less number. In the earlier stages, and particularly in the inner layers where young ones are often numerous, the spots are white; later on they become brown. They are always sunken and usually have somewhat raised edges. They begin on the outer sheaths and may be traced in through succeeding ones towards the heart of the bud. As the inner layers are softer, the inside patches are often larger than those outside, and may even give rise to new patches which extend out again to the outside sheath. In all cases, however, the first appearance is on the outer sheaths. The earlier patches are dry and either free from any appearance of a parasite on the surface or covered with a white mycelial felt. Very soon a wet rot follows, which extends with great rapidity in the delicate central tissues and converts the whole heart into a foul smelling mass of putrefaction, in which everything is involved, and the original agent is lost sight of. It is at this stage that the insect grubs referred to make their appearance, possibly attracted by the smell. They are, however, of several different kinds, often absent altogether, and evidently not connected with the disease.

It is only in the early stages before the wet rot starts that the true cause can be made out. This is a fungus of the genus *Pythium*, a near ally of the *Phytophthora* found in "koleroga." In quite young spots the mycelium is found only within the leaf tissues, where its threads extend between the cells sending little branches or haustoria into them. These are the feeding organs of the fungus by means of which it absorbs the living cell substance and kills the cells. Later on it comes out on the surface, forming often a dense white felt or filaments bearing sporangia. The fungus resembles that found in "kole roga." It is, however, formed of larger threads and has a different manner of germination of the sporangia. Instead of the zoospores escaping directly from the sporangium after it falls into the water, they come out in an immature condition into a thin bladder formed at its top and finish their development here. Then they escape and swim off in every direction. After they come to rest they germinate quickly by putting out a thread which can reproduce the whole fungus.

Dissemination may be brought about in several ways. Withering of the head may expose the inner sheaths where most of the spores are produced, or some of the latter may occasionally form on the outer layer especially on the secondary spots which develop from diseased patches in the inside; in either case they would be carried about by the wind. Once the wet rot which invariably follows has appeared, this mode of spread is not likely to occur, though there is a second spore form sometimes produced, which may be capable of surviving the general putrefaction. This second spore is a sexually produced "oospore" with thick walls and germinating in a different manner to the ordinary sporangia. It belongs to a class of spore forms whose chief function seems to be to carry on the life of the fungus plant through periods of hardship: for while the ordinary sporangia can only germinate within a few days from their time of formation, the oospores can ofter remain capable of germination for many months. It is quite possible that when the whole head has rotted away, these spores get blown about and germinate on a new palm. Insects also may assist in the spread, should they gain access to the sporebearing mycelium on the surface of the spots. Infection might also be carried by the knives of the toddy drawers, since each tree is climbed every year either to draw toddy or to cut the leaves. But whatever the usual mode of conveyance, it is evidently slow, and this is probably due to the fact that spore formation occurs usually between the inner layers of the bud, where they are not exposed to wind or any other of the usual modes of dissemination.

Nothing but the most energetic action is likely to avail in checking a disease of this kind. No remedial measures intended to cure trees already attacked are possible. The disease is invariably fatal, and only drastic measures directed to removing the source of infection can be relied on as being of the least use. In view of the fact that the area affected is small and that, so far, the disease is not known to exist outside the Godavari Delta, a vigorous effort is required to stamp it out before it has got beyond control.

The disease may be fought in two ways. The formation of spores may be checked by cutting off the bud from the stem as soon as the first leaf turns white. This entails little real loss except the cost of labour, for the palm is doomed once the early symptoms appear, and the flow of toddy on which the chief value of the tree depends is likely to be small during the remainder of its life. At the same time infection of healthy trees can be guarded against by brushing or spraying the outside of the bud below the expanded leaves with a fungicide.

The following suggestions are made for an organised campaign against the disease. A special staff is required, for it is certain that, at first at least, the villagers will be slow to take measures for their own protection. If, however, the results bear out the value of the work, real co-operation may be expected before long. A number of expert palm climbers (such as toddy drawers) should be selected under the charge of an agricultural inspector or some similar official and provided with small axes or saws. They should be instructed to climb all the diseased trees, both those in the early stages and those already dead, and to cut off the green tops below the swelling of the leaf sheaths. It is particularly essential that all trees in the early stages should be dealt with, and these can be recognized, where the villagers themselves are unable to do so, by the whitening of one of the leaves towards the centre of the head. After cutting off the heads, the whole of the tops should be collected into a heap in each village and burned. In this way every dead or attacked palm in a selected area would have its power of spreading infection destroyed by burning the diseased parts, and this measure alone, if steadily pursued, is certain to give good results. The infectious matter is confined to the head of the palm, and as the tree is doomed once the disease appears and will yield little or no further profit, its removal costs little but the actual expense of labour in cutting it down and burning it.

To save healthy trees within the affected districts, in places where they are surrounded by large numbers of dead or dying trees is difficult unless the above measures are very thoroughly carried out. But the chances of their infection may be very largely diminished if they are brushed with Bordeaux mixture on the leaf sheaths when the removal of diseased trees commences. Bordeaux mixture is a substance which adheres strongly to the surfaces of plants and, being poisonous to fungus spores, it prevents their germination or kills the young germ filaments as soon as they appear. A second gang of toddy drawers should be employed for this work and provided with small vessels containing the mixture and mops of rags for brushing it on to the sheaths. The expanded leaves need not be brushed, but only the leaf sheaths below these. One man should be able to do from 30 to 50 trees in a day, and if the work is done at the time that the trees are climbed for cutting the leaves, the cost of the labour should be small. The men employed for removing diseased trees should not be allowed to climb healthy ones, as there is some danger of their conveying the infection on their persons or axes. The cost of the materials used cannot be exactly given as it depends on the price at which copper sulphate can be landed in the district and the availability of a supply of of good lime in the neighbourhood. A pint would probably be nearly enough to treat one tree, and this should not cost more than about one pie.

To prepare 50 gallons of the mixture, weigh out 6 lbs. copper sulphate, break to powder and dissolve in 25 gallons of cold water by suspending in a piece of gunny sacking in the water. The latter must not be contained in a metal vessel but in a barrel or big earthenware pot. In another vessel weigh out 4 lbs. of fresh quicklime. Slake this gradually till it falls to powder and then add water up to 25 gallons. Allow it to cool. When cool, add to the copper sulphate solution through a sieve so as to retain any lump. A thick bluish liquid results which on standing throws down a bluish precipitate, leaving the other part of the liquid clear. To test if fit for use, add a few drops of Ferrocyanide of Potassium to a small quantity of the clear liquid in a dish. If a brownish precipitate appears, more lime must be added till no precipitate is given on testing. Or a clean steel knife may be dipped in it and if more lime is necessary, a deposit of copper will form on the knife. If none is formed it is ready for use. Stir well before using.

Similar remedies have been advocated for a coco-nut palm disease known as "bud rot," which is attracting much attention in Cuba and the West Indies at the present time. This disease has many points of similarity to the Godavari one, though different causes have been provisionally assigned for it. It has been found by Mr. Cradwick in Jamaica that spraying the trees with Bordeaux mixture when they show the first sign of disease has been effectual, and it is hoped, in Jamaica at all events, that with the use of Bordeaux mixture the disease may be kept in hand. Mr. Busck of the Division of Entomology of the U. S. Department of Agriculture, who investigated the disease in Cuba in 1901, believes it to be a fungal one and considers that its fatal nature precludes a remedy for trees already infected and leaves only the prevention of the spread of the disease as the object for man's intervention. He recommends the cutting down and burning of the tops of the diseased palms. Dr. Erwin Smith of the same Department studied the disease in Cuba in 1904. He believes the disease to be a bacterial one but gives the same general measures for treatment. Diseased trees should be felled and the terminal bud burned or properly disinfected with sulphate of copper. Mr. Petch, Government Mycologist, Ceylon, gives an account of a coco-nut disease, which he considers identical with "bud rot," in a recent circular of the Royal Botanical Gardens Ceylon. He also recommends the removal and burning of the tops of diseased trees.

To be effective it is absolutely necessary to have united action in carrying out the measures recommended above. It is useless for one village to remove the source of infection if diseased trees are allowed to remain in neighbouring fields to convey infection back again. But the opportunity is a rare one, for the limitation of the disease is such as to render concerted action possible, and there is at least a fair prospect of being able to stamp it out before it passes beyond control.

BOARD OF AGRICULTURE.

EXTRACTS FROM MINUTES.

The first monthly meeting of the Board of Agriculture since the Earthquake of 14th January, was held on Thursday 14th March; Present: Hon H. Clarence Bourne, Colonial Secretary, Chairman; the Director of Public Gardens, the Island Chemist, the Superintending Inspector of Schools, Mr. G. D. Murray and the Secretary.

The Secretary read the following letters from the Colonial Secretary's Office:—

1. *Sugar Experiment Station*—Intimating approval of the Estimates of Expenditure on the Sugar Experiment Station.
2. *Commercial Agent in London*—Re Commercial Agent in London, stating that the matter of employing a Commercial Agent in London had again been considered by the Governor in Privy Council and that the Council advised that the decision on the subject, conveyed in the letter quoted, should be adhered to, viz.: that such an agent should be appointed and maintained by the commercial community of the colony and be entirely unconnected with the Government.
3. *Deaths among Cattle*—Forwarding letter from the Secretary of the Jamaica Agricultural Society reporting that after making enquiry he found that the sudden deaths among cattle in St. Elizabeth were not due to Anthrax, but to another and easily preventable cause; that with reference to the outbreak of Texan Fever among cattle in St Andrew, on enquiry he found that the cattle were infested with ticks and that the Veterinary Surgeon called in recommended thorough washing and picking of ticks, and on this being done the deaths had stopped.
4. *Steam Drying Tray for Hampden Estate*—Intimating the approval of the grant of £50 for a steam drying tray for Hampden Estate as recommended by the Board if the approval of the Advisory Committee was first obtained. The Chemist reported that the Advisory Committee had not approved and the owner of Hampden Estate had withdrawn his request.
5. *Instructor for School Gardens*—Enclosing Memo. from Mr. J. R. Williams re Mr. P. Murray's appointment as Instructor of School Gardens. The recommendations of Mr. Williams were approved and the Secretary was directed to send a copy to the Superintending Inspector of Schools to be communicated to Mr. Murray as his instruction from the Board and a copy to the Director of Public Gardens and to the Secretary of the Agricultural Society to direct the attention of the Instructors to the suggestions contained therein.

Produce Buyers Law—The Secretary submitted memorandum from the Rev. C. H. Coles with covering letter from His Grace the Archbishop with regard to the working of the Produce Buyers License Law in the Port Royal Mountains district, with memorandum from the Secretary which he had written in reply. Both had been circulated and the reply of the Secretary was approved.

Messrs. A. A. Baker & Co., and Jamaica Rum—The Secretary submitted letter from Messrs. A. A. Baker & Co., 30 Mincing Lane London, calling attention to The Jamaica Rum Company of 442 Keizersgracht, Amsterdam, which was advertising a so-called

Jamaica Concentrated Rum and offering to give a Jamaica Government Laboratory Certificate.

A memorandum submitted from the Chemist on the subject stated that the certificate was perfectly authentic and was given to the owner of Hampden Estate to enable him to overcome the baseless and uninformed prejudice of brokers and merchants in London. The Secretary was directed to inform Messrs. Baker of this.

Instructors—The Secretary submitted letter from the Jamaica Agricultural Society stating that the Governor having approved of the proposed Joint Committee of the two Boards dealing with the actual direction of the work of the Instructors on the understanding that the Government's control of its own officers remained unimpaired and its right to utilise their services for special work was recognised, the Instructors' Committee of the Society would be glad to co-operate with a Committee of the Board.

This matter was left in the hands of the Director of Public Gardens and the Secretary who would duly report to the Board.

West India Agricultural Conference—The Secretary submitted resolutions re the West India Agricultural Conference from the Barbados Agricultural Society, from the representatives to the Conference on board the "Port Kingston" and from the Colonial Secretary's Office, Barbados, all thanking the Board of Agriculture, the Agricultural Society and the Reception Committee for their great kindness and hospitality during their stay in Jamaica.

Cotton—The Secretary submitted a report re Cotton as follows:

That he had saved the two Hand Cotton Gins out of the ruins of the office, 4 Port Royal Street, but that they would require some overhauling; that Mr. L. J. Desporte, at Halfway Tree, who had grown an acre of cotton, was having good results, that the cultivation had been visited by Sir Daniel Morris and Sir Alfred Jones who were very pleased with it, that Mr. Desporte was prepared to put in a much larger acreage, and asked for the use of one of the Gins to gin the crop. He asked leave therefore to send one Cotton Gin to the Railway workshops to be overhauled first. He also submitted samples of Caravonica Cotton grown from seed imported from Queensland.

It was agreed that the silk cotton variety was promising and that further trials should be encouraged.

Chemist's Reports—The Secretary submitted the Chemist's reports as follows:—

1. Agricultural Scholarships.
2. Report on work of Agricultural Students.
3. Report Hampden Experiment.
4. Distillery Progress in Westmoreland.

These were directed to be circulated.

Reports from Director Public Gardens.—The following reports from the Director of Public Gardens were submitted:—

1. Mr. Cradwick's and Mr. Briscoe's itineraries and reports since last meeting.
2. Reports Hope Experiment Station.

3. Letter from Mr. Cradwick re his removal, reporting that if it was arranged that he was to act as Supervisor of Instructors and would not be confined to one district he would be glad to be permitted to stay at Williamsfield as the most central place.

The Director of Public Gardens reported that the arrangements proposed depended upon the Government increasing the grant to the Agricultural Society which had not been done, and that therefore the division of the Island into six districts with Mr. Cradwick as Supervison would not be carried through, that Mr. Cradwick would have his own district and would therefore live within that district. This was approved.

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EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.,

Director of Public Gardens and Plantations.

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SOME PHOTOGRAPHS OF THE SILK-COTTON TREE (CEIBA PENTANDRA).*

With remarks on the early Records of its occurrence in America.

By MARSHALL A. HOWE.

A northern visitor in the West Indian islands naturally meets with many trees that are strangers to him and of these the silk-cotton tree [*Ceiba pentandra* (L.) Gärtn.— *Eriodendron anfractuosum*, DC.] is one of the most interesting and imposing. In point of size and in other peculiarities the tree is so striking that it has frequently been made the subject of illustration in popular magazines and travellers' guides, and occasionally also in botanical treatises, but at this time of increasing public interest in trees, it is hoped that the remarkable characters of the *Ceiba* are sufficient to justify the publication of a few more photographs for the benefit of such readers of *Torreya* as have not yet enjoyed the privilege of seeing the tree itself.

Ceiba pentandra is a member of the family Bombacaceae which is closely allied to the Malvaceae, the family to which belong the plants producing the ordinary cotton of commerce. The seeds of the *Ceiba* are covered with a soft silky fibre which is used for stuffing pillows, cushions, and mattresses. This "floss" is rather too short for weaving, but it possesses an elasticity which adapts it well for use in upholstery. From the East Indies, where also the trees occur, large quantities of this floss are exported to Europe and America under the Malayan name "kapok," though the fibre of *Bombax malabaricum* and perhaps of other Bombacaceous trees is sometimes included under the same trade-name. According to Cook and Collins,† "kapok" from *Ceiba pentandra* and related species is an article of export from the west coast of Africa also.

Perhaps the most impressive feature of the *Ceiba*, apart from its general size and massiveness, is its development, with increasing age, of peculiar wing-like buttresses at the base of its trunk. These buttresses may reach out to a distance of twelve or fifteen feet from the main body of the trunk and may have an altitude of from two to twelve feet, while maintaining an almost uniform thickness of only a few inches. The buttresses in a well-developed

* Reprinted from *Torreya* 6: 217-231. November, 1906.
† Economic Plants of Porto Rico. Contrib. U.S. Nat. Herb. 8: 111. 1903.

FIGURE 1.

FIGURE 2.

condition are shown in our Figure 1 which is from a photograph of the famous and noble tree growing in the rear of the Public Buildings of Nassau, on the island of New Providence, Bahamas. *Ceiba pentandra* is a rapidly growing tree, but this individual, in the opinion of Mr. L. J. K. Brace of Nassau, is "fully 150 years or more old." In the public library at Nassau is a sketch representing "A View of a Silk Cotton Tree in the Island of New Providence, Bahamas, May 12, 1802" this, by tradition and from general resemblance, is supposed to show the patriarch silk-cotton tree of the island—the one of which the photograph is here published—as it appeared in 1802. The tree at that time, according to the sketch, had young buttresses of a considerable size and in the judgment of Mr. Brace it must have been then at least 50 years old. The tolerably uniform and comparatively slight thickness of the buttresses make it easy to cut out parts of them for use as planks or boards, and in west Africa, according to Cook and Collins (*l. c.*) "pieces of these supporting wings are sawed out and used as doors of native houses."

In the Bahama Islands and in Porto Rico, where the writer has seen the *Ceiba* growing, the tree has a rather short and stout main trunk of about 12 to 25 feet in height up to the first branches, whence the main axis persists in diminished volume, but usually erect and easily recognizable, to the top of the tree. The main trunk, especially if one includes the basal buttresses, often has an enormous girth. According to Cook and Collins (*l.c.*) "a specimen near Ponce measured 36 meters at 4 feet from the ground, by following the sinuosities of the trunk." The main branches are very long, widely spreading and nearly horizontal, so that the horizontal diameter of the crown is sometimes more than twice as great as the total height of the tree. This feature is excellently illustrated in the Porto Rican tree of which a photograph is published by Cook and Collins (*l c. pl. 24*) and less well by our figures 2 and 6. The great spreading branches of the tree shown in our figure 3—a photograph of a tree standing on the bank of a river on the borders of the city of Ponce, Porto Rico—were put to good service at the time of the destructive Porto Rican hurricane and flood in August, 1899, when, it is said, many people saved themselves from drowning by taking refuge among the branches of this great tree. In Cuba and Jamaica, however, according to various reports, the *Ceiba* ("seiba" or "saba") sometimes takes on another form, the massive trunk running up to a height of from thirty to eighty feet* without a branch and then deliquescing into a compatively small crown. Our figure 4 illustrates such a tree growing at Mandeville, Jamaica. Mr. Norman Taylor, recently returned from a collecting expedition to the Sierra Maestra, near Santiago, Cuba, informs the writer that this form or one with a less flattened crown, is the prevailing one in the forests of that region. Professor Carl F. Baker, botanist of the Estación Agronómica Central of Cuba, also

* Lunan, Hortus Jamaicensis I, 243. 1814. Macfadyen, Flora of Jamaica, 92. 1837. Havard, Plant World 4: 222. 1901.

FIGURE 3.

FIGURE 4.

has told the writer that the form with the long trunk and less widely spreading crown is common in other parts of Cuba. The following paragraph from Macfadyen's Flora of Jamaica (93. 1837) gives a graphic description of this tree as it occurs in that island: "This is a tree of rapid growth, and is readily propagated from stakes or posts planted in the ground. A superb row of these trees at Belvidere pastures, St. Thomas in the East, was established from posts fixed in the earth, in making a common rail fence. Perhaps no tree in the world has a more lofty and imposing appearance, whether over-topping its humbler companions in some woody district, or rising in solitary grandeur in some open plain. Even the untutored children of Africa are so struck with the majesty of its appearance that they designate it the *God-tree*, and account it sacrilege to injure it with the axe; so that, not unfrequently, not even fear of punishment will induce them to cut it down. Even in a state of decay, it is an object of their superstitious fears: they regard it as consecrated to evil spirits, whose favour they seek to conciliate by offerings placed at its base."

Ceiba pentandra is one of the few tropical trees which has deciduous leaves, though its habits in this particular are somewhat erratic—a matter that has recently been discussed in an interesting way by Mrs. E. C. Anthony,* by Mr. O. W. Barrett,† and by Mr. O. F. Cook.‡ The leaves usually begin to fall at about Christmas time or early in January, and the trees are commonly bare the latter part of January and a considerable part of February and March, during which months the numerous pale rose-coloured, clustered flowers appear, followed by the pods and the leaves. Individual trees, however, behave very differently from others. The photographs reproduced in our figures 2 and 6 were taken on the same day early in March in Nassau, but the two trees there represented are shown in quite different guises. The old tree in the rear of the Public Buildings, represented in figure 2, had at the time one large branch which had apparently retained its old leaves, the remainder of the crown being entirely bare or showing clusters of flowers or young pods, while at the same time the younger tree represented in our Figure 6—a tree growing on the grounds of the New Providence Asylum—was laden with nearly mature pods and showed no leaves at all. Sometimes, according to Mrs. Anthony (*l.c.*) a silk cotton tree at Nassau may omit entirely the shedding of its leaves during the winter. The bark of the *Ceiba* is covered when young with coarse, sharp-pointed, conical or pyramidal tubercles or spines, as represented in our Figure 5, but in the older trees these spines, as a rule, are scarcely found unless near the ends of the younger branches, though in this respect the trees show a good deal of individual variation.

Ceiba pentandra is now widely distributed in the tropics, occurring not only in the West Indies and Central and South America,

* Am. Botanist 3: 90. 1902.
† Am. Botanist 4: 91. 1903.
‡ Plant World 5: 171. 1902.

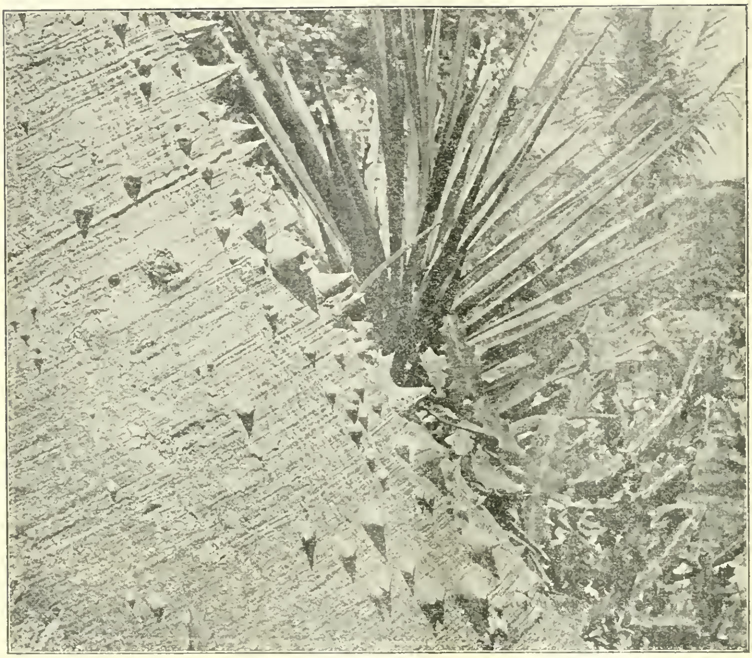

FIGURE 5.

FIGURE 6.

but also in the East Indies and tropical Africa. Taxonomists in attempts to separate speci cally the forms growing in these widely separated regions seem able to find no distinctive characters more important than slight differences in the colour of the flowers. Varietal and even specific names have been applied to forms of this tree from different parts of the world, but the practically unanimous opinion of botanists at the present day is that they represent only a single species. It can hardly be supposed that the tree is really indigenous in all these regions, and the question as to its original home thus becomes of interest. The *Index Kewensis* gives its range (under the name *Eriodendron anfractuosum*) as "As. et Afr. trop.," and the idea that the tree is an introduction in tropical America has occasionally found favour in other works. That the tree has been extensively planted in the American tropics is undeniable and its rapid growth and possession of woolly seeds easily transported by the wind are facts that may be perhaps fairly adduced to account for the presence of very large trees at the present day in forests far from human habitations. Most writers, however, consider that *Ceiba pentandra* is a native of America, and the evidence that can be assembled in support of this view seems fairly conclusive. One fact of some significance is that of the nine species of the genus *Ceiba* recognized by K. Schumann in Engler & Prantl's Die Natürlichen Pflanzenfamilien, the remaining eight are attributed exclusively to the warmer parts of America.

Pickering in his "Chronological History of Plants" (p. 783) states that *Eriodendron anfractuosum* "was carried westward across the Pacific to the Philippines" by the European colonists, and also to the neighbouring islands, to Burma, to Hindustan, to equatorial East Africa, &c., though "according to Auld seemingly 'wild in Kandesh.'" Many of the older possible references to this tree in general botanical literature are obscured by confusion with the East Indian tree now known as *Bombax Ceiba*, L. (= *Bombax malabaricum*, DC.), to which Linnaeus, over-estimating the importance of the presence or absence of spines and supposing this Malabar tree to occur in the west as well as in the East Indies, unfortunately transferred the native American name *Ceiba*. In searching through the writings of the earliest American explorers and botanical travellers, one finds a good number of references to trees which may well have been specimens of *Ceiba pentandra*, though many of these references fall a little short of being diagnostic and conclusive. Probably the earliest and certainly one of the most significant of such allusions is found in the "Select Letters of Christopher Columbus"* and occurs in a letter written by Dr. Chanca, physician to the fleet of Columbus on his second voyage to the West Indies, and relating to the island of Española (Santo Domingo). Dr. Chanca wrote:—

"We have met with trees bearing wool, of a sufficiently fine quality (according to the opinion of those who are acquainted

* 66. 1870 [2d. Ed.] Translated and edited by R. H. Major. London. (Hakluyt Soc.)

with the art) to be woven into good cloth ; there are so many of these trees that we might load the caravels with wool, although it is troublesome to collect, for the trees are very thorny, but some means may be easily found of overcoming this difficulty. There are also cotton trees as large as peach trees which produce cotton in the greatest abundance."

The editor of these letters adds as a foot note after "very thorny" ("muy espinosos"): "A species of the natural order Bombacaceae ; perhaps the *Eriodendron anfractuosum*." The "muy espinosus" in connection with a wool-bearing tree of Santo Domingo is of especial significance. *Ochroma* and perhaps other native trees of the West Indian region "bear wool," but none of them but *Ceiba pentandra*, so far as we know, is spiny.

Columbus relates in the account of his first voyoge that many canoes were found in use by the inhabitants of the islands visited and that these canoes were made of a single piece of timber. The largest of these is referred to in the journal of Columbus for Friday, November 30, 1492, at which time the explorers were at Puerto Santo [Puerto de Baracoa] near the eastern end of Cuba ; this canoe, dug out of a single tree, was 95 *palmos* (spans) long and capable of carrying 150 persons. In parts of ancient Spanish America, *ceiba*, *ceyba* or *seiba* (written "seiba" in the older documents of Cuba)* was a native name† for *canoe* and also for a certain large tree ; and many of the older writers‡ associate these large canoes with the tree now known as *Ceiba pentandra*. While possibly this is not the only kind of tree now growing in the West Indian Islands which has a trunk sufficiently large for the making of such great canoes, we have the testimony also of various later writers§ that the trunks of the *Ceiba* are used for making canoes, and Mr. Norman Taylor, whose return from a recent visit to the Sierra Maestra near Santiago, Cuba, has been referred to above, tells the present writer that he saw dug-out canoes made from the trunks of this tree now in actual use in that region. Professor L. M. Underwood in the course of his visits to Jamaica has been told that canoes are there also still made from the *Ceiba*.

The first historian of the New World, or at least the first who described the trees in much detail, was Gonzalo Fernandez de Oviedo y Valdés, who from 1514 to 1556 served in various capacities as an officer of the Spanish government in Darien, Cartagena, Nicaragua, and Española (Santo Domingo or Haïti). In 1526, he published a "Sumario de la natural y general historia de las Indias," in the course of which he remarks that "the largest tree that I have seen in these parts or in others was in the province of Guaturo.‖" (He had been speaking of the "Tierra-Firme" and "Darien" and this province was doubtless in the region of the Isthmus.) This great tree had "three roots or parts in a triangle

* A. Bachiller y Morales, Cuba primitiva, 242. 1883.

† A. Bachiller y Morales, *l.c.* 234.

‡ Sloane, Nat. Hist. Jam. 2 : 72-75. 1725.

§ *E g.*, Grosourdy, Med. Bot Criollo, 2 : 375. 1864.

‖ Edition seen a reprint in Bibliotica de Autores Españoles 22 : 504. Madrid, 1884.

after the manner of a trivet and a space of more than twenty feet was left open between each of these three" basal parts, which were also very high. There is nothing, however, in the further details of this description about the bearing of "wool," and nothing perhaps which would absolutely exclude the possibility of its being a large buttressed *Sterculia.* But in the first part of Oviedo's "Historia general y natural de las Indias," originally published in 1535, there is a chapter "On the tree called çeyba, in especial; and other big trees;" *and in this chapter, which first saw the light only forty-three years after the discovery of America, we find vivid and rather detailed descriptions of very large trees, known to the natives as "çeybas," which, in our opinion, could have been nothing other than the trees now known by the name *Ceiba pentandra,* even though two or three minor inaccuracies and misconceptions are to be noted in Oviedo's graphic and manifestly conscientious narrative. This description is of so much interest that we venture to give below a somewhat free translation of it:

"Since writing what I have said of this great tree [*i.e.* the one in the province of Guatero, mentioned above], I have seen many others and much greater ones. And it seems to me that the çeybas are for the most part the largest trees of all in these Indies; and this tree is of two kinds, one which loses its leaves, and another which never sheds them or remains always green. In this island of Española there was a çeyba, eight leagues from this city, where has persisted the name Arbol Gordo, whereof I now speak very often to the Admiral Don Diego Colom, and tell him that he with fourteen other men, touching hands, could not compass this çeyba that they call *arbol gordo.* This tree died and rotted, but many people are now living who saw it and say the same of its grandeur. For me this is not much of a wonder, recalling the larger ones of these same çeybas that I have seen on the Terra-Firma. There was another great tree of these çeybas in the town of Santiago, in this island of Española; but both this one and the other are much smaller than those that are found on the Terra-Firma.

Since in the province of Nicaragua are the greatest trees which I have seen up to this time and which much exceed all that I have told of, I will now speak only of one çeyba which I saw many times in that province, not half a league from the house and seat of the chief of Fhecoatega, near a river belonging to the district of the chief of Guaçama, who was under the protection of a man of property named Miguel Lucas or of his partners Francisco Nuñez and Luis Farfan. This tree I measured by my own hands with a hemp cord and it had a circumference at the base of thirty-three yards, which equals one hundred and thirty-two spans and since it stood on the bank of a river it could not be measured low about the roots on that side and it should be without doubt three yards larger; all put together, well measured, I estimate that it was thirty-six yards, or one hundred and forty-four spans, in cir-

*El Capitan Gonzalo Fernandez de Oviedo y Valdés. Historia general y natural de las Indias, islas y tierra-firme del mar Oceano. Primera parte, lib. IX, cap. XI. (In edition seen, I: 342-345. Madrid, 1851.

cumference. This is the largest thing in the tree line that I have seen.

The wood of these çeybas is soft and easy to cut and of little weight and the tree is not held in esteem for building or for more than two purposes. One is its wool and the other the shade, which is extensive, for these are great trees with very spreading branches, and the shade is healthful and not heavy like the shade of other trees that exist in these Indies, which are notoriously harmful; like that of the tree from which is made the poison with which the Carib Indians charge their arrows. The fruit of these trees is a pod, shaped like the largest finger of the hand, but as thick as two fingers, rounded and full of delicate wool; after ripening, these pods dry and open through the heat of the sun, and then the wind carries away the wool, in which are certain little grains which are its seeds, as is the case with the cotton. This wool appears to me to be a notable thing and the fruit of the çeyba is after the manner of the bitter cucumbers of Castile, except that the fruits of the çeyba are larger and thicker: but the largest is not longer than the great finger of the hand; and when it is ripe it breaks lengthwise into four parts, and with the first wind is seen the wool (this fruit has nothing else within it) and it looks as if it has snowed wherever the wool has sufficed to cover the ground. This wool is short and it seems to me that it could not be spun into thread; but for bed-pillows and cushions of the drawing-room (free from wet) it is a wool unique in its softness and without any ill effects to the head, and for the couches of princes the most delicate and estimable of all the wools; it is a silk and even more delicate than the subtile threads of silk. So, no feathers or wool or cotton can equal it; but, if it is wet, it all becomes balled and loses itself. I have experienced all this, and so long as this wool does not become wet there is none like it for cushions and pillows. The Indians in Nicaragua are accustomed to have appointed places for the *tiangüez*, that is to say, the market, where they come together for their gatherings, their fairs, and their barterings, and there they have two, three, and four trees of these çeybas to give shade; and in many plazas or *tiangüez*, two or three or four çeybas suffice to give shade to a thousand and two thousand persons, and they arrange the çeybas according as the concourse of the plaza or *tiangüez* is large or small. This great tree, which in this island [Española], they call çeyba, as I have said, is called *poxot* in the province of Nicaragua and in other parts bears other names."

Bartolomé de las Casas, Bishop of Chiapa, the famous pioneer missionary to the New World and defender of the Indians against their Spanish conquerors, came to Española in 1502, and spent the greater part of his long life in the West Indies, Venezuela, Peru, Central America and Mexico. His "Historia de las Indias" was known only from manuscript copies up to 1875-76 and seems not to be alluded to by any of the authors who have dealt with the silk-cotton tree, the present writer being indebted to Dr. Manuel Gómez de la Maza, of the University of Havana, for a reference to it. The description of the "ceyba" given by Las Casas is not so detailed as that by Oviedo, yet it is at least of confirmatory interest. A free translation of a part of his description* runs about as follows:

"There is in this island [Española]. and commonly in all these Indies, where the land is not cold but rather warm, trees that the Indians of this island call *ceybas*, the letter *y* long, which are commonly so great and of such copiousness of branches and dense leaves that they will give shade for 500 horses, and some will cover much more; it is a very magnificent, showy and graceful tree; its principal trunk has a thickness of more than three and four oxen, and some are found, and I believe there is one on the island of Guadeloupe, that 10 or 12 men with opened arms and even with two pairs of breeches out-stretched could not encompass, and I so affirm. * * * The mast or principal trunk before the branches commence is two to three lances in height; the first branches commence not from below upward as in other trees, but extend very straight out for such a distance that it seems marvelous that they do not break with the weight that they carry, and it is on this account that they are so capacious and make so much shade; these branches are commonly as thick as a man's body * * *; the leaves are dark green, delicate and toothed,† if memory serves me well; I do not know that there is in Castile anything to which to compare them, unless it may be, if I am not mistaken, those of what we call the tree of paradise."

In view of the evidence of the kind quoted and of the various corroborative traditions,‡ it would appear that tropical America has a good claim to being considered the native home of the silk-cotton tree. Just what the direct evidence may be for Pickering's§ unqualified assertion that the tree "by European colonists was carried westward across the Pacific to the Philippines," and also to India and Africa, we have been unable to discover, but the idea seems plausible. Sir George Watt, in his "Dictionary of the Economic Products of India"‖ remarks that "No writer definitely affirms that *Eriodendron* is wild; nearly all speak of it as cultivated." If evidence can be found showing the existence of this tree in the Indies prior to the discovery of America, it will naturally raise some interesting questions of the kind recently discussed by Mr. O. F. Cook¶ who finds grounds for believing that the cocoa-nut

* Las Casas. Historia de las Indias. Coleccion de Documentos Inéditos para la Historia de España, 66: 322, 323. 1876. [Apéndice capitulo XIII.]

† The editor of the "Historia" states that Las Casas began the writing of it when he was 78 years old, which would be after his return to Spain.

‡ There is a Cuban tradition to the effect that the first mass on the present site of the city of Havana, in 1519, was celebrated, according to a tablet erected in 1754 in commemoration of the event, under "una frondosa seiba." A photograph of this tablet is reproduced in "El Mundo Illustrado" of November 20, 1904 (p. 310), a copy of which we owe to the courtesy of Professor de la Maza of Havana. The accompanying account in "El Mundo Illustrado" states that the original ceiba was cut down in 1753, was replaced by another which died out during the building of the commemorative "El Templete" in 1828, but seeded two other trees, one of which still remains.

§ Chonological History of plants. 783. ‖ 3: 260. 1890.

¶ The origin and distribution of the cocoa-nut palm. Contr. U. S. Nat. Herb. 7: i—v. 257-293. 1901. The American origin of Agriculture. Pop. Sci. Monthly 61: 492-505 O 1902.

palm and several other important food plants of wide distribution in the tropics originated in America and were transported by human agencies to Polynesia, the East Indies, and Africa, in very remote times, or at least in times much antedating the discovery of the New World by the Spaniards.

REPORT ON THE DIPLOMA EXAMINATION HELD IN JAMAICA, DECEMBER, 1906.

Government Laboratory,
Barbados, 12th March, 1907.

Sir,

I have the honour to forward herewith a report upon the results of my examination for the Diploma of Agriculture at Jamaica. Five candidates presented themselves for examination, the subjects being Agriculture, Chemistry of Agriculture, Botany, Entomology, and Elementary Physics; and the syllabus of each of these subjects was similar to that of 1904.

2. All the candidates passed, L. L. Carrington being placed in the first Class. Of the candidates who passed in the second Class C. S. Lindo deserves to be commended. I am glad to be able to express the opinion that the answers afford evidence of sound and careful teaching and that the results of the examination are very satisfactory.

I have the honour to be,
Sir,
Your most obedient Servant,
J. P. deALBUQUERQUE,
Island Professor of Chemistry and Agricultural Science.

H. H. Cousins, Esq., M.A., F.C.S.

Examination for Diploma in Agriculture.
JAMAICA, 1906.

Subject.	Full Marks.	L. L. Carrington	C. S. Lindo.	S. Dailey.	P. L. Irving.	T. U. Dixon.
Agriculture .	200	123	113	90	83	91
Chemistry of Agriculture .	200	156	134	121	104	90
Botany .	100	60	55	62	52	62
Entomology .	50	48	28	21	34	25
Physics .	50	40	41	33	34	36
	600	427	371	327	307	304
Percent. of total:—		71	62	55	51	51

All the candidates passed. L. L. Carrington is placed in the 1st Class. Of the candidates who passed in the 2nd Class, C. S. Lindo is to be commended.

J. P. deALBUQUERQUE, M.A., F.I.C., F.C.S..
Island Professor of Chemistry and
Agricultural Science, Barbados,
Examiner.

Agriculture.

The questions involving practical local knowledge, Nos. 4, 7, 8, as well as Nos. 1 and 6, were very well done by one or other of the candidates. The effects of drainage were well understood but no one gave good practical directions for carrying it out. No satifactory answer was sent in on irrigation and the answers on rotation of crops were generally weak. L. L. Carrington's paper was on the whole very good indeed and C. S. Lindo's was good. The rest were fair to fairly good.

Chemistry of Agriculture.

Only one candidate made the calculation in the second part of question 2 correctly: the formulæ were wrongly used in two cases and in two the arithmetic was at fault. The answers to 3 on Chlorine were rather weak. All candididates evidently knew the answer to question 8 on the Physical and Chemical Analysis of soils but no one expressed the answer quite clearly: no candidate sent in a satisfactory attempt on question 4.

Clearness and brevity of expression and arithmetical accuracy appear to the examiner the chief points in which to aim at improvement.

L. L. Carrington attempted eight questions and did well in all but one. His paper was a very good one. C. S. Lindo answered three questions very well and his paper as a whole was good. S. Dailey's was good, P. L. Irving's very fair, and T. U. Dixon's moderate to fair.

Botany.

In no case was question 1 well answered. C. S. Lindo spent apparently half his time in answering question 2. His answer was good but quite unnecessarily long. The process of sexual reproduction was exceedingly well described but only one candidate clearly expressed the object of artificial fertilization. The botanical description of a plant was generally well done and especially so by L. L. Carrington. The account of cassava manufacture was sketchy. Question 6 was very well answered by L. L. Carrington. If the candidates had avoided undue length in some questions compelling undue brevity in others, I think they would have secured a higher percentage of marks.

Entomology.

L. L. Carrington did a very good paper indeed and showed a clear knowledge of the bearing of entomology on practical problems. None of the others knew what a contact poison was. With this exception the paper was well done.

Physics.

This short paper was well done: only two candidates gave a proof of the formula for a pulley showing its mechanical advantage, only one candidate gave an experimental example of the parallelogram of forces and only one candidate in the first part of question 4 did more than state Pascall's law.

General Remarks.

I am of opinion that the answers afford evidence that all the subjects have been well and carefully taught: and as one who is deeply interested in, and has had some experience of the difficulties of the establishment of, Agricultural Secondary Schools in the Tropics, I am satisfied that the results of the examination fully justify the effort made in Jamaica.

J. P. DEALBUQUERQUE, M.A., F.I.C., F.C.S.,
Island Professor of Chemistry and
Agricultural Science, Barbados,
Examiner.

CARAVONICA COTTON.

Seeds of the Caravonica Cotton were obtained from Dr. Thomatis, Australia, and distributed,—a few being sown at Hope Gardens.

Samples of both varieties were sent to Mr. E. L. Oliver for opinion as to value, and he has very kindly sent the following letter regarding them :—

Liverpool, 19th February, 1907.

E. L. Oliver, Esq.,
Bollington.

Dear Sir,

We report upon the undermentioned samples as follows :—

	Values.
CARAVONICA COTTON, NO. 1.	
White, staple $1\frac{3}{4}$ inch, very strong, inclined to be harsh, but finer than Caravonica as grown in Australia, which is used as a substitute for Rough Peru to mix with wool. Buyers of such would not give over about 11d. per lb., but if, owing to the climate of Jamaica, the staple became finer, it would be a substitue for Abassi which is now worth 14d. & 15d.	12d. nom.
CARAVONICA COTTON, NO. 2.	
Similar in character, no finer, rather shorter in length, Probable value when ginned	11d.

We are,
Yours faithfully,
(Sgd.) WOLSTENHOLME & HOLLAND,

The "Agricultural News"* prints the following note :—

In reply to a request from the Imperial Commissioner of Agriculture to be supplied with information as to the variety of cotton produced in Queensland and known as Caravonica, of which mention was made in the *Agricultural News* (Vol. V, p. 358), the Secretary of the British Cotton-growing Association has written as follows :—

Your letter with enclosure relating to Caravonica cotton to hand. This cotton, which is probably a hybrid of Sea Island and Rough Peruvian, does not at all compare with the West Indian Sea Island. The statement that 'of all the cottons collected by the Association the Caravonica was adjudged the most valuable, &c.,' is not correct. It is very undesirable that any of this seed should be used in the West Indies, as the cotton lacks most of the essential characteristics of the Sea Island.

*Vol. VI. No. 126, 23 Feb., 1907.

The following is an extract from a letter from Messrs. Wolstenholme & Holland of Liverpool, to the British Cotton-growing Association, dated December 28, 1906 :—

In reply to your enquiry, the Caravonica cotton referred to sold at 9d. per lb. and the owner has been offered 9½d. for the following crop, which is now worth 10d. owing to the present scarcity of Peruvian.

CITRON.

By George Loutrel Lucas.

The citron, "Citrus Medica," grows partly wild in many parts of Jamaica and to the best of my knowledge, no attention has ever been given to its cultivation.

It is one of the oldest cultivated fruits known to man and is the only one known to classical writers according to Hume.

"In Media and Persia and later in Palestine, it was cultivated "at a very early date and in these countries the Greeks and "Romans probably first met with it.

"By Pliny's time, the fruit had been sufficiently long in cultivation to receive a number of names and he is the first to make "use of the name "Citrus"— the botanical name afterwards "adopted by Linnaeus for all the related fruits as well as the "citron.

"It was finally established in Greece, Italy and the adjacent "Islands of the Mediterranean and became one of the important "fruits in those regions into which it was introduced and where it "grows to this day in large quantities.

"It is surmised that it found its way into South Africa from the "Mediterranean and thence to the West India Islands, at a very "early date, probably introduced by the Spaniards."

The consumption of candied citron in the United States amounts to near 4,000,000 pounds annually. the most of which comes from Leghorn, Italy, being candied after reaching the United States.

England consumes large quantities of candied citron and like the United States, imports it in 10 to 12 per cent. brine in casks.

No doubt some trade could be worked up with the United Kingdom in this article, but only the best sorts should be cultivated, and care must be exercised in growing such fruits as will make the best appearance, with thick flesh and as little bitter principle as possible ;—there are several good kinds, but the Corsican is considered the best. Trees should be planted 20 x 20 feet and rough lemon stocks used in preference to citron stocks which have a bad habit of suckering and making ungainly looking bushes instead of symetrical trees.

The citron tree is less subject to disease and least susceptible to insect attacks than all the Citrus family, and it is easy to grow if proper cultivation is followed, and there is no reason why this neglected fruit should not be looked after and some attention paid to an industry that might at least assist in adding to the income of Jamaica.

The citron is simply cut in halves either way, the seeds scooped out, and without peeling, the pieces are thrown into the brine, coopered up and shipped in casks ; the reason so much is shipped this way is because it saves the duty and the fruit is well washed and candied after the importer receives it, but whilst this is the only way to sell advantageously in the United States, I think a good trade can be worked up in the candied article with both the United Kingdom and Canada.

The following is a good receipt for making

CANDIED OR GLACE CITRON.

If the citron has been in brine, wash the slices or pieces or halves in running water to remove all the salt, and blanch in plain water, keeping near the boiling point but do not actually boil, as this breaks the fruit and separates the pulp from the skin.

When the pieces are soft, cool in running water for 6 hours at least to remove the bitterness contained in the fruit.

Place in stone jars and pour over hot syrup at 14° Baumé, made from the best granulated cane sugar, drain and reboil every 2 days increasing the strength each time until 28° is reached, then leave 3 days between each draining until 33° is reached when the fruit should be transparent and thoroughly saturated ; dry finally and pack in small boxes lined with white paper, and ship.

Either green or ripe citron may be used, but the trade prefers a green colour and the green fruit should only be used. The citron is cut into halves as the handiest shape to use, and if to be exported in brine, only halves will meet with sale, but for home consumption, smaller pieces will answer. And before I close I would like to remark that all the good housewives in this Island buy their citron from the local grocers to use in their cakes—all of which is imported from the United States and England where it is candied after having been imported into those countries in brine.

CASSAVA TRIALS IN 1907.

Native and Colombian Varieties.

By H. H. COUSINS, M.A., F.C.S., Island Chemist.

The previous records of the Experiments in the cultivation and starch-value of Cassavas as carried out at Hope have been published in the Bulletin of the Department of Agriculture, vol. 1 pp 35-38, 130-134 vol. 2 pp 37-42, 49-51, vol. 3 pp 152-155, 218, 219, vol. 4 pp 73-76.

We are now able to report upon the yield, starch-value, dietetic quality and hydrocyanic acid content of the series of cassavas collected in the interior of Colombia by Mr. Robert Thomson and first reported upon in 1903. A record of the starch yields from 22 selected native varieties of cassava after 12 months growth has also been obtained and is now set forth.

COLOMBIAN VARIETIES.

A collection of 26 varieties representing the entire stock obtained by Mr. Robert Thomson was secured for the Hope Experiment Station and was propagated until fairly large plots of about

1-10 acre in size could be planted out in April, 1906. Speaking generally, the growth of these cassavas compares unfavourably with that of our best native varieties of cassava and only 6 out of the 26 varieties can be regarded as of any apparent value as starch producers under the conditions obtaining at Hope. It is quite possible that in the hills some of these varieties would flourish and prove of real value to small cultivators. It is suggested that a stock of these Colombian varieties should be offered to any branches of the Agricultural Society in the mountain districts for trial by the members. Two of the varieties can be considered as worthy of serious attention as starch producers in the plains: "Miguela" and "Negrita 15." The former gave a return of 13·3 tons tubers and over 9,000 lbs. starch per acre, while the latter yielded 11·4 tons of tubers and 7,863 lbs. starch.

At the same time a native variety of sweet cassava, "Luana Sweet," has given under the same conditions the same yield of tubers as "Miguela" with a higher starch content amounting to 10,015 lbs. per acre and the victory rests with the local variety in the competition as to starch production. It is possible that "Miguela" and "Negrita 15" will improve as they become more acclimatised and they must be regarded as valuable varieties.

Hydrocyanic Acid Content.

These Colombian varieties, however, were not imported as starch-producers but as wholesome food free from risk of poisoning by hydrocyanic acid. As grown in Colombia these cassavas are stated to be quite non-poisonous. After a year's growth in the Liguanea plains of Jamaica they were tested in this laboratory and 14 varieties were found to contain on the average .0034 per cent. of hydrocyanic acid in the whole tubers.* After a further period of four years growth in the same changed locality the hydrocyanic acid content rose to .0124 per cent. or practically *four fold.*

This was predicted by Messrs. J. Shore and J. T. Palache from their knowledge and experience of growing cassavas from higher elevations at a lower. The increase is mainly due to the cortex. This averages .0649 per cent. hydrocyanic acid while the edible portion only contains .0026 per cent. Of the total percentage of .0124 hydrocyanic acid, 81 per cent. or .0100 exists in the cortex and only 19 per cent., on the average, is contained in the edible portion.

According to Carmody's rule, in bitter cassavas the hydrocyanic acid is almost equally distributed throughout the cortex and interior of the tubers, while with sweet cassavas the greater proportion of poison exists in the cortex. This is well borne out by all these cassavas except two, "Palo Verde" and "Cajon Amarilla" both of which from the distribution of hydrocyanic acid should be "bitter" cassavas whereas they are to the taste "sweet" and were found by actual experiment on four persons to be non-poisonous.

* The figures for hydrocyanic acid given on p. 37 of vol. I. should be doubled, owing to an error in caculating the results of analysis.

It would appear that the "sweet" or "bitter" character of a cassava is not directly connected with its content of hydrocyanic acid but is dependent upon the presence or absence of some bitter principle. This is obvious since some "sweet" cassavas contain as much hydrocyanic acid as "bitter" varieties; and in any case there would be gradations of bitterness dependent upon hydrocyanic content. The real cause of "bitterness" in cassava has yet to be ascertained and it would appear that Carmody's rule is not altogether a reliable criterion for discriminating between sweet and bitter varieties, although undoubtedly applicable to our native varieties of cassava

Edible Properties.

It seemed desirable to obtain evidence as to the eating qualities of these Colombian varieties of cassava and a select committee consisting of two chemists, the messenger, the stillerman, the cook and the laboratory boy, was appointed to taste and appraise the flavour of the 25 varieties. The carpenter proved to be a cassava enthusiast and added himself to the committee so that the opinions recorded may be considered to be fairly representative. It was soon apparent that there was a division of tastes the majority favouring the mealy type of tuber—dry and floury, like a good potato, well boiled—while a minority with depraved taste, consisting of the boy and the carpenter, gloried in 'gumminess' and rejoiced in gelatinous slime.

After the committee had completed the serious task of passing judgment on the 25 varieties, the carpenter complained that although he had purchased an appetising lunch he found himself unable to taste it. Fortunately, there were no serious symptoms, and the trouble proved to be due, not to cyanogenetic action, but to over-confidence in internal accommodation.

The messenger declared himself ready to continue his duties on a sweet cassava committee daily, so long as a supply was obtainable. On the whole these cassavas gave great satisfaction and were considered of unusual quality and of great filling power. The following varieties are selected from this trial as being varieties giving a good yield of tubers of high edible quality :—

Mealy Varieties.	Soft Varieties.
1. Negrita 15	1. Governor Hemming
2. Cenaguera	2. Cajon Amarilla.
3. Negrita 11	
4. Helada 4	

The results are given in detail in a series of tables, I—V. Table I gives the tonnage and the description of the stem, foliage and habit as determined at the Hope Experiment Station by W. Harris, Esq., F.L.S., the Superintendent. Table II gives a description of the character of the tubers as to colour, skin, size and shape of tuber as recorded at the Laboratory by Mr. G. D. Goode. Table III records the yields and composition of the tubers of the 26 varieties arranged in order of indicated starch yield per acre. The specific gravity as determined by the cassava balance, and the content and distribution of the hydrocyanic acid are also given. Finally, a comparison of the starch and hydrocyanic acid found is compared with that previously recorded for 1903. This work, as that in table IV, is mainly that of Mr. F. N. Thompson of the Laboratory staff. Table IV gives the distribution of the total hydrocyanic acid as between the cortex and the interior. The percentage of the total found in the cortex is also given in view of Carmody's Rule previously referred to. Table V summarises the majority's opinion upon the edible qualities of the series of varieties.

TABLE I.

Field Records of Colombian Varieties.

Name.	Yield per per acre.	Description of Plants
	Tons.	
Ceiba	3.79	Stem slate colour, moderately high, moderate grower, leaves 7-lobed.
Helada 4	4.98	Grey stem, moderate grower, branches low, leaves 7-lobed.
Helada 5	4.98	Grey stem, branches low, 7-lobed.
Helada 6	3 98	Same as Helada 5.
Helada 7	3.98	Weak grower, below average height, stem grey, leaves 5-lobed.
Helada 9	2.84	Stem grey, weak grower, branches low, leaves 6-lobed.
Helada 14	5.31	Dark red stem, straight, moderate grower, leaves 6-lobed.
Negrita, Bitter	7.96	Stem grey, robust grower, branches spread, leaves 7-lobed.
Negrita 12	4.98	Dark green, moderate grower, leaves 7-lobed.
Negrita 14	3.32	
Negrita 15	11.38	Average height, stems dark brown, good grower, leaves 7-lobed.
Negrita 17	5.31	Stem dark green, moderate grower, leaves 7-lobed.
Negrita 18	4.98	Stem dark grey, moderate grower, leaves 7-lobed.
Blancita	4.68	Stem grey, branches low, moderate grower, leaves 7-lobed.
Cenaguera	7.21	Stem slate colour, branches low, moderate grower, leaves 5-lobed.
Governor Hemming	8.85	Stem grey, moderate grower, branches low, leaves 5 to 7-lobed.
Montera	4.68	Exactly as Helada 14.
Palo Verde	6.12	Stem slate colour, branches fairly high, robust grower, leaves 5 and 7-lobed.
Pata Paloma	6.12	Stem brown, average height, fair grower, leaves 7-lobed.

Miguela	13.28	Stem slate colour, branches high, robust grower, leaves 7-lobed.
Pie de Paloma	4.98	Stem grey, moderate grower, straight stems, leaves 5-lobed.
Cabesa Dura	5.31	Stem dull red, branches low, inclined to spread, moderate grower, leaves 5-lobed.
Pie de Perdiz	4.19	Stem dull red, grows straight, moderate grower, leaves 7-lobed.
Solida Blanco	6.12	Stem grey, branches low and spreading, moderate grower, leaves 5 and 6-lobed.
Cajon Amarilla	7.21	Grey stem, branches low, inclined to spread, moderate grower, leaves 6 to 7-lobed.
Pacho, No. 3	3.06	Slate colour, moderate grower, branches low, leaves 6 and 7-lobed.
Unnamed	3.98	Slate colour, moderate grower, branches fairly high, leaves 5 and 6-lobed.

Table II.

Colombian Varieties—Description of Tubers.

Variety.	Description of Tubers.			
	Colour.	Skin.	Size.	Shape.
Helada 4 ...	Light	Smooth	Medium	Tapering
Helada 5 ...	"	"	"	"
Helada 6 ...	"	"	Short	Thick
Helada 7 ...	"	"	Small	Cylindrical
Helada 9 ...	"	"	Medium	Tapering
Helada 14 ...	Dark	Rough	Short	"
Negrita 11 ...	Light	Smooth	Long	Cylindrical
Negrita 12 ...	Dark	Rough	Short	Thick
Negrita 15 ...	"	"	Medium	Cylindrical
Negrita 17 ...	"	"	Long	"
Negrita 18 ...	Light	Smooth	"	Tapering
Blancita ...	"	"	Medium	"
Cenaguera ...	Dark	Rough	Short	Thick
Governor Hemming ...	"	"	Long	Tapering both ends
Montera ...	"	"	Medium	Tapering
Palo Verde ...	"	"	Short	"
Pata Paloma ...	"	"	Medium	Thin
Miguela ...	"	"	Long	Tapering both ends
Pie de Paloma ...	Light	Smooth	"	Tapering
Cabesa Dura ...	Dark	Rough	"	"
Pie de Perdiz ...	"	"	Medium	"
Solida Blanco ...	"	"	Small	Cylindrical
Cajon Amarilla ...	"	"	Short	Tapering
Pacho 3 ...	"	"	Medium	"
Unnamed ...	"	"	"	"

TABLE III.

TRIAL OF TWENTY-FIVE VARIETIES OF COLOMBIAN CASSAVAS.
Hope Experiment Station, 1907.

Period of growth 12 months.

Order in Starch Value.	Variety.	Tubers.	Total	Sugars.	Starch.	Specific Gravity of Tubers	Indicated starch per acre. lbs.	Hydrocyanic Acid.				Starch.	
								1907,			1903.		
		Tons per acre.	Solids.					Cortex o/o.	Inside o/o.	Total o/o.	Total o/o.	1907.	1903.
1	Miguela ...	13.3	39.47	1.52	30.54	1.1415	9,099	.0478	.0093	.0149	...	...	...
2	Negrita 15 ...	11.4	46.50	1.25	30.79	1.1709	7,863	.0392	.0010	.0084	.0038	30.79	34.80
3	Cenaguera ...	7.2	42.52	1.45	35.18	1.1765	5,674	.0658	.0009	.0135	.0028	35.18	25.00
4	Governor Hemming ...	8.9	39.10	1.33	30.17	1.1312	5,672	.0612	.0019	.0100	.0036	30.17	36.50
5	Cajon Amarilla ...	7.2	43.26	1.49	31.02	1.1364	5,003	.0893	.0017	.0176	.0060	31.02	33.30
6	Negrita 11 ...	8.0	41.49	1.35	27.87	1.1709	4,994	.0791	.0028	.0101	.0040	27.87	27.70
7	Solida Blanco ...	6.1	40.17	1.33	32.11	1.1338	4,388	.0865	.0013	.0114	...	...	...
8	Helada 4 ...	5.0	42.27	1.35	34.70	1.1468	3,886	.0743	.0029	.0112	...	...	...
9	Helada 5 ...	5.0	41.65	1.72	33.27	1.1547	3,726	.0648	.0016	.0100	.0014	33.27	34.30
10	Negrita 17 ...	5.3	44.65	0.95	32.95	1.1628	3,912	.1203	.0057	.0265	.0070	32.95	23.90
11	Palo Verde ...	6.1	35.28	1.11	26.69	1.1338	3,647	.0238	.0074	.0154	...	...	...
12	Pie de Paloma ...	5.0	40.70	1.52	32.42	1.1494	3,631	.0700	.0016	.0097	...	...	...
13	Blancita ...	4.7	41.39	1.02	34.44	1.1600	3,626	.0638	.0016	.0119	.0018	34.44	33.80
14	Negrita 12 ...	5.0	41.00	1.16	31.79	1.1628	3,561	.0398	.0010	.0073	.0020	31.79	31.10
15	Negrita 18 ...	5.0	41.31	1.18	31.30	1.1628	3,506	.0567	.0012	.0100	...	...	...
16	Pata Paloma ...	5.0	45.18	1.32	31.18	1.1628	3,492	.0366	.0026	.0070	.0034	31.30	34.30
17	Cabesa Dura ...	5.3	41.44	1.72	28.68	1.1389	3,405	.0525	.0010	.0090	.0020	28.68	35.40
18	Helada 14 ...	5.3	35.80	1.43	27.43	1.1520	3,332	.0540	.0039	.0130	...	...	...
19	Montera ...	4.7	38.56	1.45	29.75	1.1389	3,132	.0762	.0036	.0154	.0018	29.75	25.00
20	Helada 7 ...	4.0	42.59	1.52	31.93	1.1494	2,861	.0767	.0010	.0146	...	...	...
21	Helada 6 ...	4.0	41.20	1.33	30.72	1.1494	2,752	.0781	.0019	.0119	.0038	30.72	29.90
22	Pie de Perdiz ...	4.2	37.33	1.54	28.45	1.1468	2.677	.0636	.0022	.0108	...	...	...
23	Unnamed ...	4.0	36.33	1.69	28.71	1.1136	2,572	.0399	.0007	.0084	...	...	...
24	Ceiba ...	3.8	37.99	1.96	30.14	1.1364	2,565	...	...	...	...	...	...
25	Pacho 3 ...	3.1	46.60	1.18	34.85	1.1628	2,420	.1029	.0045	.0200	.0044	34.85	22.30
26	Helada 9 ...	2.8	35.52	1.10	29.66	1.1286	1,860	.0585	.0019	.0111	...	...	...
Average	26 Colombian Cassavas ...	5.7	41.9	1.38	31.07	1.1490	3,971	.0649	.0026	.0124	.0034*	31.63*	30.52*

* Average of 14 varieties.

Table IV.

Hydrocyanic Acid in Colombian Cassavas.
Hope Experiment Station, 1907.

No.	Variety.	Total Hydrocyanic Acid, per cent. In Cortex.	In Interior.	Total.	Percentage of Total Hydrocyanic acid in Cortex.
1	Negrita 17 ...	.0219	.0046	.0265	83
2	Pacho 3 ...	.0162	.0038	.0200	81
3	Cajon Amarilla ...	.0062	.0114	.0176	35
4	Montera ...	.0124	.0030	.0154	81
5	Palo Verde ...	.0024	.0130	.0154	16
6	Miguela ...	.0068	.0081	.0149	46
7	Helada 7 ...	.0138	.0008	.0146	95
8	Negrita 14 ...	.0119	.0019	.0138	86
9	Cenaguera ...	.0127	.0008	.0135	94
10	Helada 14 ...	.0098	.0032	.0130	75
11	Blancita ...	.0105	.0014	.0119	90
12	Helada 6 ...	.0103	.0016	.0119	87
13	Solida Blanco ...	.0103	.0011	.0114	90
14	Helada 4 ...	.0087	.0025	.0112	78
15	Helada 9 ...	.0095	.0016	.0111	86
16	Pie de Perdiz ...	.0089	.0019	.0108	82
17	Negrita 11 ...	.0077	.0024	.0101	76
18	Helada 5 ...	.0086	.0014	.0100	86
19	Negrita 18 ...	.0085	.0015	.0100	85
20	Noto Seves ...	.0084	.0016	.0100	84
21	Pie de Paloma ...	.0083	.0014	.0097	86
22	Cabesa Dura ...	.0082	.0008	.0090	91
23	Negrita 15 ...	.0076	.0008	.0084	90
24	Unnamed ...	.0079	.0005	.0084	94
25	Negrita 12 ...	.0065	.0008	.0073	89
26	Pata Paloma ...	.0048	.0022	.0070	69
Average .	26 Varieties ...	.0100	.0024	.0124	81

Table V.

Colombian Cassavas. Variety.	Culinary Properties. Quality when cooked.
1 Solida Blanco	Too hard.
2 Cenaguera	Rather solid but mealy.
3 Helada, 14	Very good. Mealy.
4 Pacho, 1	Good flavour. Gelatinous.
5 Pie de Paloma	Good. Mealy.
6 Negrita, 12	Sweet and mealy.
7 Helada, 6	Hard. Flavourless.
8 Governor, Hemming	Soft and sweet. Excellent.
9 Helada, 4	Fine flavour. Mealy.
10 Unnamed	Soft sweet. Gelatinous.
11 Helada, 9	No flavour. Very inferior.
12 Pata Paloma	Very good. Sweet. Gelatinous.
13 Helada, 5	Good flavour. Sweet. Gelatinous.
14 Blancita	Rather hard. Good flavou r.
15 Pie de Perdiz	Poor flavour. Inferior.

TABLE V., *continued.*

Colombian Cassavas. Variety.	Culinary Properties. Quality when cooked.
16 Negrita, 18	Very good. Mealy. Rather bitter taste.
17 Negrita, 15	Excellent. Mealy.
18 Negrita, 17	Sticky. Inferior.
19 Pacho	Mealy. Excellent flavour.
20 Helada, 7	Good quality. Mealy.
21 Montera	Flavourless. Very inferior.
22 Miguela	Very hard.
23 Palo Verde	"Not worth eating."
24 Negrita, 11	Mealy. Excellent flavour.
25 Cajon Amarilla	Excellent flavour. Sweet and glutinous.

NATIVE VARIETIES OF CASSAVA.

The trial of our selected native varieties is being continued and the results of 22 varieties after 12 months growth have been obtained.

The highest place is taken by "Luana Sweet" with over 10,000 lbs. starch per acre while Duff House, Black Bunch of Keys, Brown Stick, Blue Top, Bobby Hanson and Black Bitter Long Leaf Blue Bud, come fairly close together. The variety that led at 12 months in 1906 is now 8th on the list, although it gave slightly greater returns than on the previous occasion. Despite a season of most abnormal rainfall these native varieties have yielded a return that can only be called amazing. These results indicate that cassava can surmount seasonal disadvantages and give an enormous yield of starch under very unfavourable conditions.

Speaking of the attempts made by planters to grow cassava on a large scale, one fault must be strongly emphasised in their method of cultivation. In any soil but a light, free draining medium, cassava must be grown on raised hills or ridges and adequate drainage is absolutely necessary. The tubers rot at once after heavy rains unless free drainage is secured.

There is no longer any doubt as to the great possibilities of cassava as a starch producer in Jamaica and the Starch Industry is one that should receive the serious attention of capitalists and planters alike.

Table VI sumarises the results obtained with the 22 varieties of native cassava. An inspection of the specific gravity figures leads to the conclusion that the variations between different varieties are such that it would not be possible accurately to assess the starch value of miscellaneous deliveries of tubers at a factory by the use of the cassava balance.

Preparation of Cattle Food.

Experiments are being made as to the drying of the cassava bitty or refuse from the starch manufacture and its conversion into a useful feeding meal by incorporation with one-third of its weight of guango pods. The results already obtained indicate that such a mixture could be easily prepared and that the flavour is good, and that the mixture possesses a high nutritive value for cattle, pigs and other stock. Many scores of tons of guango pods rot and waste annually in St. Catherine that might be utilised in this way.

TABLE VI.

Trial of selected Native Varieties of Cassava, Hope Experimental Station, 1907.

Period of growth 12 months.

Order in Starch production.	Variety.	Tubers. Tons per acre.	Total Solids.	Sugars.	Starch.	Specific gravity of Tubers.	Indicated yield of Starch per acre in lbs.	Previous Records in 1906.	
								Starch yield at 12 mos. 1906.	Starch yield at 18 mos., 1906.
1	Luana Sweet ...	13.3	45.36	1.35	33.61	1.1655	10,015	5,322	7,102
2	Duff House ...	11.4	43.91	0.89	35.69	1.1600	9,114	4,107	12,632
3	Black Bunch of Keys ...	11.4	45.83	.	34.85	1.1415	8,899	2,388	8,894
4	Brown Stick ...	11.4	44.11	1.10	34.37	1.1494	8,777	2,384	8,927
5	Blue Top ...	11.3	44.00	1.43	34.62	1.1547	8,763	5,636	15,818
6	Bobby Hanson ...	11.4	39.21	1.03	33.38	1.1364	8,524	4,777	8,197
7	Black Bitter Long Leaf Blue Bud	11.2	45.66	0.80	32.59	1.1655	8,176	4,462	7,567
8	White Top ...	10.0	41.15	1.20	36.00	1.1574	8,064	7,902	8,753
9	Luana Bitter ...	8.9	46.57	1.20	39.25	1.1520	7,825	3,075	6,425
10	Rodney ...	9.3	45.58	0.89	32.51	1.1415	6,773	5,337	6,547
11	New Green ...	8.9	41.06	1.03	30.89	1.1442	6,158	3,192	6,895
12	Prize Stick ...	6.1	49.46	1.00	39.43	1.1682	5.388	2,634	10,666
13	White Stick ...	6.1	47.62	0.72	32.61	1.1709	4,456	2,522	9,742
14	Smalling ...	5.7	42.65	1.20	34.84	1.1494	4.448	5,494	13,883
15	Pine White ...	5.7	44.69	0.96	33.97	1.1734	4,337	.	.
16	Mullings ...	5.7	41.53	1.39	33.57	1.1600	4,286	4,160	13,277
17	Fustic Sweet ...	5.7	44.62	1.16	32.75	1.1494	4,182	.	.
18	Long Leaf Blue Bud ...	4.7	45.73	1.09	37.98	1.1792	3,999	6,552	13,187
19	Silver Stick ...	5.0	40.41	1.01	33.92	1.1442	3,799	2,744	8,574
20	Black Stick ...	5.3	46.93	0.66	31.33	1.1876	3,724	4,878	15,433
21	White Bunch of Keys ...	4.7	43.12	1.52	34.54	1.1547	3,636	4,069	7,466
22	Brown Stick, Long Leaf Bitter	4.4	39.79	1.19	32.73	1.1494	3,226	.	.

THE CEYLON RUBBER EXHIBITION, 1906.

The following account of the Ceylon Rubber Exhibition has been sent for publication by Dr. J. C. Willis, Director, Royal Botanic Gardens, Ceylon :—

An extremely successful Exhibition of Rubber has lately been held (September 13-27) in the Royal Botanic Gardens at Peradeniya, Ceylon, and marks a distinct stage in the progress of this great new industry, an industry which owes its inception and progress entirely to the forethought and aid of scientific men at the various Botanic Gardens of Kew, Ceylon and Singapore.

Extensive buildings were erected in the Kandyan (or Sinhalese mountaineer) style of architecture, and were well filled with exhibits of raw rubber in its different forms from the plantations of

Ceylon, the Malay Peninsula and India, tools for the tapping and collecting of latex, manufactured rubber and rubber goods, and other things, besides exhibits of raw rubbers from all corners of the globe. Two large sheds were also filled with machinery for the treatment of the latex, and there were interesting side-shows as well.

We do not propose to go into detail as to the exhibits, but to give some of the chief facts connected with the industry, and some of the chief lessons learnt at the exhibition.

Ten years ago there was practically no rubber in cultivation of the Para kind (*Hevea brasiliensis*), the kind that is now almost exclusively attended to. Seed was then all but impossible to obtain, and though a small 'boom' in this product took place in Ceylon in 1898-9, the supply of seed was too small to allow it to go far. Only since 1902 has there been plentiful seed, and the industry has expanded very rapidly till now in Ceylon there are about 110,077 acres, in Malaya about 60,000, and in other countries probably 46,000, say 200,000 acres in all, to say nothing of perhaps 100,000 acres of *Castilloa elastica* in Mexico.

The primitive methods of tapping the trees in V's with a hammer and chisel have now gone out, and the favourite methods are to cut spirals or herring-bones on the trees, and pare the edges of the cuts at intervals of from two to ten days, thus getting the advantage of the wound-response discovered by the writer in 1897, and worked out in detail by Mr. Parkin in Ceylon in 1898-9. The second tapping of a given area gives more latex than the first, and the amount often continues to increase for some time.

For paring the cuts there were many knives exhibited, and gold medals went to the Bowman-Northway and Miller knives, both of which are simple, keep sharp, and pare thin shavings without any dragging of the cut edges. It is very important that the shavings should be thin, as the bark should be made to last about four years before it is all cut away, in order to allow the renewed bark time to ripen fully.

The yields obtained on some estates have been phenomenal, but it is probable that in many of these cases the bark has been too rapidly cut away, and that a period of waiting for the renewed bark to ripen will ensue. It is not as yet safe to count on more than a pound a year a tree, if so much; but even this means 150 lb. to 200 lb. an acre, an amount sufficient at present prices to yield an enormous profit.

Hitherto the Ceylon rubber has mostly appeared upon the market in the form of 'biscuits'—flat pancakes about 10 inches in diameter. The Malayan has mostly been in 'sheets' about 2 feet long. But both these forms seemed destined to disappear in favour of block—rubber prepared by blocking the sheets, biscuits, or other form under high pressure. Some samples of block were shown by Lanadron estate, Johore, and similar samples have lately been getting the highest prices on the market.

The Ceylon and Malayan rubber has been obtaining higher prices per pound than any of the 'wild' rubbers, even 'fine Para' the standard of the market, but pound for pound of pure rubber is really getting lower prices, for the Para rubber contains about 20 per cent. of moisture. Why this should be so is one of the greatest problems before the investigator at the present moment.

Any one comparing a sample of fine Para with one of any plantation rubber—Ceylon, Malayan, or Mexico—can see at once that the former is more springy, returning more readily to the original shape when stretched. The higher price really obtained for this rubber may, therefore, probably be explained on this consideration.

Now, is it because the trees are young that the rubber is weaker, or because the rubber is not smoke cured? Is it because the rubber is in biscuit or sheet instead of in blocks? Is it that it is too much dried (Para rubber contains 20 per cent. of moisture)? Is it that it is too pure and too much washed? Or is it that it is not coagulated in the best way? All these, singly or in combination are possible explanations, and there may be others.

There is no doubt that older trees give stronger rubber, but that of even the oldest trees in Ceylon—thirty years old—is not equal to South American Rubber. Smoke-curing (without coagulation at the same time) seems to strengthen the rubber, and block rubber, besides a saving in cost of freight, and exposure of less surface to oxidation, seems actually stronger than sheets or biscuits. The great dryness of the plantation rubber may also have something to do with it, and experiments are now being tried by the Peradeniya institution in the preparation of block from wet biscuits.

To any one looking forward a little, one of the most interesting exhibits in the show was the vulcanized and coloured rubber exhibited by Mr. M. K. Bamber, Government Chemist in Ceylon. Mr. Bamber acts, not on the coagulated and macerated rubber, but directly on the latex with the necessary reagents, and then coagulates, giving a perfect intermixture.

The coagulated rubber can then be worked up into whatever is required in the ordinary way, and finally heated, when it vulcanizes. One of the most promising of his exhibits was the mixture of fibre and rubber. The fibre, cleaned, is soaked in sulphurized rubber milk, coagulated and then dried, and finally subjected to hydraulic pressure and vulcanized, the result being blocks suitable for pavement, &c. By this method, rubber can also be turned out of any colour desired, and the colour will not wash or crack off—a great advantage for children's toys. One of the most noteworthy features of the exhibition was a series of daily lectures on the various parts of the rubber industry—cultivation, tapping. shipment to London, vulcanization, catch crops, pests, &c., &c.; and these lectures with the reports of the judges, description of the machinery and other things, are now being put together in a book which will form a standard treatise,* to be in the hands of every one interested in rubber.

* *The Ceylon Rubber Exhibition Handbook:* by J. C. Willis, M. K. Bamber, and E. B. Denham. To be obtained about the end of the year from Messrs Dulau & Co., 37 Soho Square, Messrs. Wyman & Sons, Ltd., Fetter Lane, London, for 7s. 6d. net.

MANILA BEAN IN JAMAICA.

In April, 1906, a few seeds of Manila Bean (Psophocarpus tetragonolobus) were received from the Bureau of Agriculture, Manila, Philippine Islands. These were sown and the young seedlings were put out along a wire fence at Hope Gardens where they flowered freely in November and December, and produced pods from which a good supply of seed has been saved. It is intended to cultivate a plot of this plant in the Experiment Station this year.

In the Agricultural Ledger, 1906—No. 4 (Calcutta) Mr. I. H. Burkill, Reporter on Economic Products to the Government of India, gives an account of the history, uses, and cultivation of this bean.

The plant is a native of the Malay Archipelago, and was probably introduced into India. It is an annual with violet-blue flowers which are succeeded by pods of square section when cut across and are winged along the four edges. The root is long and fleshy like an oblong turnip. There are several varieties, distinguished by length of pods, breadth of wings, and colour of seeds.

The pods, while still green and tender, may be cut into short segments and cooked, being used like French beans, to which they are but slightly inferior in flavour. The ripe beans are not recommended as food as they are said to make the head heavy, though roasted, they are used as food in Java.

The fleshy root is dug up before any seeds are allowed to ripen, and boiled. It is eaten by the Burmese, without cooking, between meal times, as a delicacy. It is slightly sweet, firm like an apple, and by no means unpleasant. If the seeds are allowed to ripen the roots get dry and less pulpy. The plant likes a considerable amount of moisture.

In the Shan States the seeds are planted when the rains begin, three inches deep in village gardens, or forest clearings, generally where the burning of rubbish, branch-wood etc., has manured the soil. The plants are trained on supports like yams and grow ten to twelve feet in height.

In Burma, the land is harrowed and hoed into furrows, between which ridges two feet broad and a foot high are prepared with a spade, one and a half feet apart in order not only to admit air and water freely but to drain off water effectively. Then the seeds are buried in small holes about three by six inches apart, specially prepared for the purpose on the ridges. Weeds are periodically removed, but stakes are not used, the plants being left to trail along the ground.

The average yield is over 48 cwts. of tubers per acre, and the net profit amounts to about 25/. The margin left to *bona fide* cultivators after trouble and expenses would by itself not be encouraging, but a bumper crop of sugar-cane is usually grown in the year after a crop of Manila beans. It is said that the cane crop, if preceded by Manila beans, yields half as much again as usual. The trade in the roots is a large one, and they are sent in considerable quantities more than 200 miles by rail or river.

RECENT EXPLORATIONS IN JAMAICA.

Report to the Board of Scientific Directors of the New York Botanical Garden, by Dr. N. L. BRITTON, Director-in-Chief.*

By permission of Mr. D. O. Mills, President of the Board of Managers of the Garden, I devoted the period between August 25 and October 1 to botanical exploration in the island of Jamaica, taking advantage of the kind invitation of the Hon. William Fawcett, Director of the Public Gardens and Plantations to visit the island. I was accompanied by Mrs. Britton, by Professor L. M. Underwood, Chairman of the Scientific Directors of the Garden and by Miss Delia W. Marble. Professor Alexander W. Evans, of Yale University and his assistant, Mr. Nichols, were with us a part of the time.

Although much is known of the flora of Jamaica, considerable areas of the island have been only imperfectly explored, and some of the regions accessible only with difficulty and by the expenditure of much time, have not yet been visited by botanists. One object of the expedition was to determine upon the most practicable plans for reaching these unexplored regions, the most noteworthy of which are the so-called Cockpit Country, in the west central part of the island, and the John Crow mountains at the extreme eastern end.

We spent a week in the eastern edge of the Cockpit Country, centering at Troy and at Balaclava, under the guidance of Mr. William Harris, Superintendent of Public Gardens and Plantations of Jamaica, who had previously made several trips to this region and penetrated farther into it than any other botanist had been able to do. During these trips he has made extensive botanical collections, including many species of trees and shrubs new to science; his work of collecting has been carried on for several years in coöperation with the garden, and we have received from his department a complete series of all the plants secured; he led me to many of the novelties found by him, and we secured additional specimens of them; we also detected a number of other new species, including some of great interest. The region is a very rough one physiographically, consisting of a very porous limestone eroded into characteristic hills and deep hollows, the ragged edges of the rocks making passage through it, except on the few roads and trails, exceedingly and necessarily slow to avoid dangerous tumbles; it has a general elevation of some 2,000 feet above the sea, its highest hills said to reach 2,700 feet, and its climate is delightful; naturally, it is very sparsely populated; we concluded that its complete exploration could only be accomplished by means of a pack-train and camp outfit, using existing trails and penetrating laterally from them as far as possible on foot; there is no doubt that this method would bring out many additional novelties, as the distribution of plants there is very local, and I hope it may be accomplished before some of them are lost

* Journal of The New York Botanical Garden. Vol. VII., No. 83 pp. 245-250.

to science by the somewhat irresponsible cutting of timber which is now going on.

A week was given to collecting in the higher portions of the Blue Mountains, using Cinchona, the garden's sub-tropical station and laboratory as a base, and the party enjoying while there the delightful hospitality and kindly aid of Mrs. William Fawcett, wife of the Director of Public Gardens and Plantations. Expeditions were made to the summit of Sir John Peak, the second highest mountain of the range, along a trail recently cut out by means of contributions of students who have used the laboratory, which opens up a surprisingly interesting tract of mountain forest at altitudes of 6,000 to 7,000 feet. Here the bryologists of the expedition revelled in the wealth of rare mosses and liverworts which clothed the tree-trunks, the shrubs and the ground, forming cushions and festoons of entrancing beauty : in spite of a tropical down-pour of rain which finally drove us to shelter in a hut three or four miles from the summit where a fire and hot coffee soon made everybody cheerful, and the return to Cinchona was made without incident and the collections safely housed. John Crow Peak, a much better known mountain of 6,000 feet altitude, was also visited, and extensive collections made there and at lower altitudes.

The buildings and grounds at Cinchona, leased by the Garden from the Jamaica government in 1903, for use as a sub-tropical station and laboratory have been repeatedly described. I had not visited them before, however, and was naturally much interested in examining the establishment, which is all that is necessary for the purposes : the buildings have been kept in repair and the grounds in good order by the Jamaica government. Professor Underwood will present to you a detailed report on the work hitherto accomplished by students at Cinchona, together with considerations relative to the future of the station. A visit of about three days was made to Hollymount, near mount Diablo in the central part of the island, where collections were made, and, under the guidance of Mr. Harris, I was able to study and collect at several points in the vicinity of Kingston, in the part of the island which has the least rainfall, and where cacti abound. Through his collections and my own we have now secured living specimens of all the cacti known to grow in Jamaica, except one small and little known species : this is a *Mamillaria* accredited to Jamaica by Linnæus, but not found there in many years : it is especially interesting as the type of the genus *Mamillaria*, mostly globose plants, so rich in species in Mexico and in the arid portions of Arizona and New Mexico : I greatly desired to rediscover it, having found the related species *Mamillaria nivosa* on Culebra Island, Porto Rico, last Spring, and hope that the Jamaica botanists may yet run across it. The largest Jamaica cactus is the plant known as *Cereus Swartzii*.

The Jamaican palms were also made a subject of special study, and I was fortunate in being able to see nearly all the kinds known and to collect herbarium specimens ; seeds and young plants of several of them were also obtained; the most remarkable of them is a fan-thatch species, presumably of the genus *Thrinax*, abundant in the woods covering the limestone hills about Hollymount, which reaches a height of 50 feet with a trunk only about 6 inches in diameter; its flowers and fruit are unknown to botanists and are apparently produced only sparingly and at long intervals; examination of several hundred trees failed to reveal them, and other botanists have had a like experience, but the old fruit-stalks seen on several trees prove that they do occur at times.

Another very interesting species of *Thrinax* grows in great quantities at the mouth of Priestman's River at the extreme north-eastern part of the island; this is a small tree, none seen by us being over 15 feet high, having large clusters of stalked milk-white fruits nearly half an inch in diameter.

The largest native palm on the island is the cabbage-palm, the trunk of which sometimes reaches a height of 100 feet; the royal-palms of Cuba and Porto Rico do not grow naturally in Jamaica but are freely planted for ornament. In order to study the plants of the wettest part of the island we traversed the region from Port Antonio eastward to Priestman's River, fortunately on a day with insignificant rainfall; this brought us to a view of the John Crow Mountains, the other region which I have referred to as least known botanically, but we did not get within five or six miles of the range: inquiries indicate that the pack-train method will be the only satisfactory way of exploring them.

Parts of several days were spent at the public gardens at Hope, in studying the plantations and herbarium; Mr. Harris very obligingly gave us great assistance here, allowing us to prepare and pack all our collections, and arranging for their shipment; and to this coöperation much of the success of the expedition is due.

In addition to its function as a public garden and park, Hope is a very important centre of botanical and horticultural investigation, serving also as an agricultural experiment station.

The public garden at Castleton located near the centre of the island was also visited and the plantations studied with much interest and profit; this is a very wet region, permitting the growth of very many plants not adapted to the much drier climate at Hope; and a very notable collection of economic tropical trees from all parts of the world has been brought together here, including probably the most complete series of palms to be found anywhere in America, all in fine condition.

The collections of prepared specimens and of living plants made during the expedition include about 1,600 numbers, aggregating some 5,000 specimens, and are an important addition to our representation of West Indian species, the duplicates being available for exchanges; some valuable plants from the gardens at Hope and at Cinchona were also obtained.

Our thanks are gratefully tendered to His Excellency, Sir Alexander Swettenham, Governor of Jamaica, to the Hon. William Fawcett, Director of Public Gardens and Plantations, and to Mr. William Harris, Superintendent of Public Gardens and Plantations.

REPORT ON THE CONDITION OF THE TROPICAL LABORATORY.

Report to the Board of Scientific Directors of the New York Botanical Garden by DR. L M. UNDERWOOD, *Professor of Botany, Columbia University.**

It is now just ten years since serious agitation was first aroused among American botanists relative to a tropical Botanical Laboratory. Commencing in November, 1896, the Botanical Gazette published a series of editorials on the subject† and a commission was appointed to consider Jamaica with special reference to such an establishment, two of the members of the commission actually visiting the Island early in 1897. For various reasons the interest waned, and no further steps were taken until, in response to the present writer‡ the buildings at Cinchona were leased from the Jamaica Government by the New York Botanical Garden for a period of ten years from August, 1903, and thus an outfit practically ready for occupancy was secured where American botanists could take advantage of all needed facilities for tropical work under the most favourable circumstances.

Cinchona takes its name from the extensive plantations of that tree which were installed by the Jamaica Government over forty years ago with the intention of producing its drug on a commercial scale. So far as leased by the Garden, Cinchona consists of a six-roomed house with accessory kitchen, store room, and stable, three office buildings suitable for dormitories and capable of housing eight or ten people in addition to the house proper with its four large sleeping apartments, two low green houses sufficient for cultivation under glass of such plants as require more moisture than that afforded by the outside atmosphere, and two laboratories large enough to accommodate nearly a dozen workers. These buildings form the greater part of the government experiment station established in 1874, which under Sir Daniel Morris (1879–1886) and later (1886–1897) under the Hon. William Fawcett was the residence of the government botanist and the centre of botanical work in the Island. The physical, climatic and floral conditions at Cinchona, as well as the sanitary conditions of the location, demand attention as forming the real basis for recommendation as a tropical laboratory where students accustomed to a more temperate climate may desire to study for a longer or shorter period. These may be summarised topically:

1. Location.—Cinchona is situated on a spur of the Blue Mountain range on the southern (xerophytic) exposure at an elevation of 4,950 feet above the sea. It is most easily reached from Kingston via Gordon Town which is connected with Kingston by one of Jamaica's splendid carriage roads, and from which two good bridle-paths lead to Cinchona either over Content Gap or past Guava

* Journal of the New York Botanical Garden. Vol. VII, No. 83, pp. 250-225.

† Botanical Gazette, 22: 415-416, 494-495. 1896; 23; 47-48, 126-127, 202-203. 1897. Cf. also letters on the subject in same journal, 22: 496-497. 1896; and 23 50-51, 54, 129, 207-208, 291. 1897.

‡ Cf. Journal N. Y. Bot. Gard. 4: 109-119. 1903.

Ridge. A driving road from Buff Bay on the north coast reaches Silver Hill Gap seven miles from Cinchona and is in process of construction to Chester Vale, three miles nearer.

2. Climate—A daily record of the temperature, condition of the atmosphere, and rainfall, has been kept for the past twenty-five years, and from the published data we learn that the temperature ranges from about 47° to 74° F., rarely exceeding these limits. The rainfall is about 103 inches, being of course much less than on the northern slope of the range where it locally reaches 100-200 inches, though much more than at the really xerophytic portion of the island in the vicinity of Kingston. In general, the month of May and some part of the period from September to November include the principal rainy seasons so-called.

3. Sanitary Conditions—For ordinary domestic purposes, rain-water accumulated in three large cisterns, furnishes an adequate supply. For drinking purposes and for cooking, water is brought from the source of the Clyde river which forms here a large limpid brook rising about six hundred feet below Cinchona. This water is cold, clear, and as nearly absolutely pure as natural water derived from the earth could possibly be. There being no residence other than Cinchona higher than the sources of the stream and no cultivation even above its water-shed, there are absolutely no sources of contamination.

From a residence at Cinchona at three different periods of the year, January-February, 1903, April, 1903 and September, 1906, the writer can personally testify as to the healthfulness and desirability of the location. When we add to an ideal climate the rugged mountain scenery of Jamaica which is spread out in every direction, with the harbour of Port Royal and the golden Caribbean nearly a mile below, the magnificent and ever-changing cloud effects now above, now below the observer—and about him a well-ordered tropical garden (still maintained as a public garden by the Jamaican government), with tall *Eucalyptus, Grevillea, Juniperus and Podocarpus* trees, with tree-ferns and many other tropical plants, and with a wide variety of magnificent rose bushes blossoming at every season, we have a picture where " every prospect pleases" and where every feature appeals to the esthetic sense and contributes in a marvellous degree to the real pleasure and contentment of living.

4. Flora.—The botanical features of Jamaica are very rich and diversified. In 1893 Mr. Fawcett compiled a list of Jamaica plants largely from Grisebach's Flora of the British West Indies (1864) which enumerated about two thousand species of seed-bearing plants. To this list the persistent field work of Mr. William Harris has added nearly a fourth more. As is well known, the ferns and their allies form an unusual ratio to the seed-bearing plants and Jamaica possesses more species of these groups than any other equivalent area of the entire world. These were studied by the late Mr. Jenman, whose collections became the property of the Garden in 1903. With the later additions made to Jenman's work the number of species exceeds

five hundred, or perhaps one-sixth of the higher flora, and at least two-thirds of these are found within a radius of ten miles with Cinchona as a centre. The mosses are abundant and some grow in the greatest profusion in the higher altitudes; they have only recently been studied with any degree of thoroughness. The same may be said of the hepatics, of which probably a greater number exists than of the true mosses. Lichens are abundant and have been only partially studied. The algae which swarm in the tropical waters of the coast have been partially collected and have been listed by Mr. F. C. Collins, yet this group awaits further study. Of all the groups of plants the fungi alone seem to be deficient in number of species as compared with temperate regions, although no very serious mycological work has yet been done in the island. Within easy reach of Cinchona we find abundance of original forest conditions. Naturally shrubs and trees form the larger portion of the terrestrial element of the higher plants, while epiphytic bromeliads, orchids, and aroids, parasitic Loranthaceae and succulent Piperaceae and Urticaceae exist in great profusion. The Eusporangiate ferns are represented by *Marattia* and several species of *Danaea*, and by three genera of Ophioglossaceae; six species of Gleicheniaceae form thickets at the higher elevations wherever land had once been cleared: the moist woods beyond the divide abound in numerous representatives of Jamaica's large array of endemic tree-ferns, and filmies (Hymenophyllaceae) are found on every bank, log and standing trunk, while epiphytic species of *Polypodium* and *Elaphoglossum* appear in bewildering variety, especially in the elevations above five thousand feet. Along the single trail from Cinchona to Morce's Gap (three miles) over one hundred species of ferns can be seen without leaving the bridle path.

Since the Laboratory at Cinchona was leased by the Garden some sixteen persons have made studies at Cinchona. The writer spent two periods of several weeks each at Cinchona just prior to the date of the lease, making a study of the ferns: on the second visit he was accompanied by Mr. William R. Maxon of the U. S. National Museum, and by Dr. Johnson and Mr. Forrest Shreve from Johns Hopkins University. During the summer of 1903 Dr. D. T. MacDougal visitied the station and accomplished the formal leasing of the property for the Garden.

The later students at the laboratory are as follows:

1903. Professor A. W. Evans, of Yale University, made extensive collections of the Hepaticae. He was accompanied by one of his students, Mr. George E Nichols, who made collections of the higher flora.

1904. William R. Maxon, of the U. S. National Museum, spent some time studying the ferns of Jamaica. Miss W. J. Robinson, instructor in Vassar College, spent several weeks studying the early stages of certain filmy ferns.* Miss Mary M. Brackett, of

*For Miss Robinson's impression of Cinchona, cf. Jour: N. Y. Bot. Garden 5: 187-194. 1904.

Wadleigh High School, remained during the same period, making a study of the embryology of certain Loranthaceae.*

1905. Clara E. Cummings, professor of botany in Wellesley, spent several weeks investigating the lichen-flora of the region. She was accompanied for a part of her stay by Martha E. Merrow, botanist of the Rhode Island Agricultural College. Later in the season and continuing until the late spring of 1906, Dr. Forrest Shreve, of Woman's College, Baltimore, was in charge of the Laboratory and engaged in a variety of ecological and morphological studies.†

1906. Professor D. S. Johnson, of Johns Hopkins University accompanied by two graduate students, spent some weeks at Cinchona continuing his morphological and embryological studies, especially in the Piperaceæ and the Chloranthaceae. Of his students, Mr. I. F. Lewis made a study of the fresh water algae of the Blue Mountain region, collecting about fifty species representing thirty genera, of which sixteen had not hitherto been reported from the island; and Mr. W. D. Hoyt made a study of the prothallia of the Hymenophyllaceae and *Psilotum*.

Later in the season, Professor A. W. Evans of Yale University made further studies of the Hepaticae, and his assistant Mr. George E. Nichols made a study of the distribution of the mosses of the region. Both these gentlemen were in residence at Cinchona when Dr. Britton accompanied by Mrs. Britton and Miss Delia W. Marble and by the present writer made a short visit to Cinchona, of which Dr. Britton has given a full account in the present number of the Journal. Of the sixteen botanical students that have made use of the laboratory at Cinchona, six have already made a second visit.

Already the success of the laboratory at Cinchona has justified the wisdom of the selection of this site for a laboratory. In leasing the grounds and buildings the Garden has done all that could be reasonably expected of a single institution.

A well ordered tropical laboratory is open to American botanists, easily accessible, delightful as a place of residence, surrounded by a most magnificent tropical flora offering problems without limit, and a wealth of botanical experience is now attainable by American students at a minimum expense, unattended by the ordinary discomforts and dangers common to tropical lands. If American botanists and botanical teachers really want the advantages of a tropical botanical laboratory, they now have it in their power to coöperate to make Cinchona as profitable a botanical Mecca as the famous old world laboratory at Buitenzorg.

RUBBER CULTIVATION IN THE BRITISH EMPIRE.

The above is the title of a lecture lately delivered by Mr. Herbert Wright before the Society of Arts, and now reprinted

*A popular account of Cinchona experiences is given by Miss Brackett in The Plant world 8: 6–12, 29–31. 1905.

†A brief report of Dr. Shreve's work may be found in this Journal, 7: 193-196 1906.

from the "Journal" of the Society by Messrs. Maclaren & Sons of the "India-Rubber Journal," London.

The headings of the sections of the lecture will give some idea of its scope; they are:—Source of Rubber, Botanical Sources of Caoutchouc, Distribution of important Caoutchouc Plants, Rubber Species, Wild Rubber, Distribution of Rubber Plants and the Eastern Industry, Plantation Rubber, Laticiferous and Caoutchouc Plants.

The last named section, from page 53 to page 71, deals with the following subjects:—Differences between the Laticiferous System of Different Genera—Collecting Latex and Manufacture of Rubber—Methods of Tapping on Eastern Plantations—Systems of Tapping in vogue—Frequency of Tapping and Wound Response—Coagulation of the Latex by Acids, Alkalies, Plant Juices, Heat, etc.—Yields of Rubber obtainable—Manihot, Castilloa, Funtumia, and Hevea—Best Yields from Original Cortex—Future Yields from Renewed Cortex—Yields from Young and Old Trees—Approximate Yield per Acre according to distance—Exceptional Yields—Yield according to system—Latex from different sections of the tree—Noncoaguable Latex from high Parts—Labour and Yields on Small and Large Plantations.

The information comprised in these 20 pages out of 100 in the book will probably appeal most to the practical planter.

The lecture gives a good birds-eye view of the whole subject, and should be read by all who are interested in rubber. The planter who has trees ready for tapping will want not only this small book but also Mr. Wright's manual on "Para Rubber."

GUAYULE RUBBER.*

Considerable interest has of late been attracted to what is known as 'Guayule' rubber in Mexico. The following information in regard to this plant is extracted from an article in *Tropenpflanzer*, for May 1905:—

The 'Guayule' (*Parthenium argentatum*) is a low perennial composite about 2 feet high, with grey bark, silvery leaves, and inconspicuous yellowish flower heads on long stalks. It is widely spread along the dry calcareous steppes of the northern part of the high plateaux of Mexico, at an elevation of 2,800 to 5,200 feet.

This plant yields no latex when wounded, but the caoutchouc is in closed cells in the bark and the wood. To extract the rubber the whole plant is dried, ground up, and as much of the woody matter as psssible removed from the small round lumps of rubber which result from the grinding. The rest of the woody matter is then dissolved with hot alkali. and the rubber pressed into large, flat cakes.

The product contains as much as 10 to 27 per cent. of resins and aromatic substances, and has sold for 1s. 5d., to 2s. 4d. per lb. One factory is now working, and four others are planned. It is

* From *The Agricultural News*, V. 122.

estimated that the plants growing wild contain about 30,000 tons of this rubber, which will supply the factories for some years. Some 7 to 12 per cent. of impure rubber can be obtained from the plant.

EXTRACTS FROM A PAPER "ON THE ACCUMULATION OF FERTILITY BY LAND ALLOWED TO RUN WILD."*

By A. D. HALL, M.A., *Director of the Rothamsted Experimental Station (Laws Agricultural Trust.)*

It is well known that the fertility of "virgin" soils is due to the accumulation of *débris* of a natural vegetation which has been in occupation of the soil for a long epoch previously. Only when the climate and rainfall are suitable to the growth of the plants and the partial preservation of their residues, does a virgin soil of any richness arise: on the one hand, virgin soil may be as poverty stricken as the most worn-out European field because it has never carried any vegetation; on the other hand, as in the tropics, the *débris* of an extensive vegetation may decay with such rapidity that no reserve of fertility accumulates. In temperate climates, and with a particular distribution of the annual rainfall, occur the grassy treeless prairies and steppes which provide the ideal conditions for the accumulation of fertility. But that fertility does increase when land is in the state of permanent grass has long been an axiom in our farming: the results set out below will serve to show at what rate the increase takes place under prairie conditions in England, *i. e.* when the land is left absolutely to itself and not even grazed by stock.

In 1882, about an acre of the upper end of the Broadbalk field at Rothampsted, which had then been carrying wheat for forty years in succession, was not harvested, the crop was allowed to stand and shed its seed without cultivation of any kind. In the following season a fair quantity of wheat came up on this part of the field, but gradually got weaker as the season advanced and the weeds increased their hold on the land. The wheat was still left to struggle on without cultivation, and by the fourth season only three or four stunted plants could be found, each carrying but one or two grains in the ear. With these the wheat disappeared and has never been seen again in that part of the field. This illustrates the fact that our farm crops have become so specialised that they are unable to exist in competition with weeds and other natural vegetation and are entirely dependent on cultivation to relieve them from that competition. The piece of land in question has been left untouched since that time, and has covered itself with a coarse grassy herbage interspersed with thorn bushes and briars, young oaks, and other shrubs of the district. Before, however, these shrubs could meet and establish a continuous covert they were stubbed from one portion so as to leave the herbaceous and grassy vegetation only in possession. This piece of

* From *The Journal of Agricultural Science,* Vol. I, Pt. 2, May, 1905.

land now represents the result of something more than 20 years of prairie conditions in England, and as samples of soil had been taken at starting it affords an opportunity of gauging the rate at which fertility is accumulating. A very similar experiment was also made with a portion of the Geescroft field, which had carried beans from 1847 to 1878 and clover from 1883 to 1885; after the second cutting of clover in 1885 the field was fenced off and has been left untouched ever since...............

Both fields show a marked gain of carbon and nitrogen down to the third depth of 27 inches, the increase in the lower depths being due to the roots which have decayed in that stratum..........

If the total amounts of nitrogen in the Broadbalk soils be calculated on the assumption that the weights of the soil layers were the same in 1904 as in 1882, the total gain of nitrogen per acre would amount to 2,200 lbs., which is at the rate of more than 100 lbs. per acre per annum. So great an accumulation of nitrogen is manifestly impossible to account for in the present state of our knowledge . . . The Geescroft field shows a similar though smaller increase in the proportion of carbon and nitrogen down to the depth of 27 inches; considering the surface soil only the difference in the amount of nitrogen accumulated by the two fields amounts to about 350 lbs. per acre. The fact that the increase on Geescroft is smaller than on Broadbalk is of considerable interest, because after the Geescroft sample had been taken in 1883 clover was grown for three years before the land was allowed to run wild. Moreover the soil was sampled again in 1885, after three years' growth of clover, and showed in the surface soil an increase of nitrogen . . . The Geescroft field had in fact some start of the Broadbalk field, why did it not maintain its lead? The answer is probably to be found in the botanical composition of the wild herbage which has taken possession of these two bits of waste.

It should be remembered that previously the Broadbalk land had been growing wheat, the Geescroft field beans until they would grow no longer, then a good crop of clover. At the present time the vegetation on the Broadbalk waste contains a fair proportion of leguminous plants, chiefly meadow vetchling, while this class of plants is and has been for many years, since the dying out of the clover, absent from the Geescroft waste. It is impossible to refrain from correlating the absence of leguminous herbage on these old bean and clover plots with the well-known fact that land becomes "sick" of the leguminous crops in a way that never happens with the other farm crops......... The absence of leguminous herbage collecting nitrogen from the atmosphere would explain why the Geescroft field has gained nitrogen less rapidly than has the Broadbalk field with its more mixed herbage.

Another question however arises: how comes it that the Geescroft land, with no plants growing on it which are capable of fixing free nitrogen, has yet gained an enormuus quantity of nitrogen during the twenty years under review, a quantity which at the lowest reckoning amounts to about 25 lbs. per acre per year? The nitrogen brought down in the rain would account for perhaps

5 lbs. per acre per annum, a little more will come in the form of dust, bird-droppings, and other casual increments, while some may be due to fixation of atmospheric nitrogen by bacteria in the soil not associated with leguminous plants, like the *Azotobacter chroococcum* of Beyerinck and Winogradsky's *Clostridium Pastorianum.* The *Azotobacter* has been found abundantly in the Rothamsted soils, and as in the case of grass land like the present the decaying vegetation would supply the carbohydrate which the bacterium must oxidise in order to fix nitrogen, it is quite possible that it may have effected considerable gains of nitrogen. Two other causes may be at work, the absorption of atmospheric ammonia by soil and plant, and the rise of nitrates from the subsoil. To what extent the traces of ammonia in the atmosphere are absorbed by the soil, as distinct from the washing down of ammonia by the rain, is still a matter of uncertainty, the investigations of Kellner and of Schloesing indicate a comparatively high figure, about 40 lbs. per acre per ann m as a maximum. But a gain of nitrogen from this source should be even more in evidence on the arable than on grass land, yet the unmanured plots on the arable land do not show any similar amounts of nitrogen either in soil or in crop. Again, though practically no nitrates are found in the drainage water immediately below grass land, both because nitrification is slow and the living plant is active in taking up the nitrates as fast as they are formed, yet nitrates are comparatively abundant in the permanent subsoil water. No data exist on the subject, but it is not unreasonable to suppose a certain amount of capillary creep of these nitrates up to the zone where the surface vegetation could reach them. Only by the capillary movements of subsoil nitrates, laterally or vertically, can one understand how trees in many places continue to obtain the requisite nitrogen for their yearly increase. However, from one cause or other, this Geescroft field during its twenty years of lying in rough natural vegetation does show an increase in fertility which is not entirely easy to account for on ordinary lines.

EXTRACTS FROM A PAPER ENTITLED "THE EFFECTS OF PLANT GROWTH AND OF MANURES UPON THE RETENTION OF BASES BY THE SOIL.*

By A. D. HALL and N. H. MILLER *of the Rothamsted Experimenta Station* (*Lawes Agricultural Trust*).

The communication "deals with the changes in the amount of calcium carbonate, the chief substance in the soil acting as a base, which are brought about by natural agencies, by manuring, and particularly by the growth of plants."

The following summarised statement of results is appended :—

"1. Arable soils which contain upwards of 1 per cent. of calcium carbonate are subject to a normal loss of that constituent in

* *Proc. R. Soc.* B. Vol. LXXVII, p. 1-32, 1906.

the drainage water amounting to about 800 lbs. to 1000 lbs. per acre per annum.

2. The loss is increased by the use of ammoniacal manures by an amount equivalent to the combined acid of the manure. The loss is diminished by the use of sodium nitrate or organic debris like farmyard manure.

3. The growth of plants normally returns to the soil a large proportion of the basis in the neutral salts which the soil provides for the nutrition of plants.

4. The calcium oxalate and other organic salts of calcium present in plant residues are converted by bacterial action in the soil into calcium carbonate.

5. The return of base by the growth of plants and the production of calcium carbonate by the decay of plant residues are sufficient to retain soils neutral which are poor in calcium carbonate, and to replace the basis which have been consumed in nitrification and similar changes."

EXTRACTS FROM A PAPER ON "THE ANALYSIS OF THE SOIL BY MEANS OF THE PLANT."*

By A. D. HALL, M. A., *Director of the Rothamsted Experimental Station (Lawes Agricultural Trust.)*

One of the main problems placed before the agricultural chemist is the estimation of the requirements of a given soil for specific manures, or the interpretation, by means of data obtained in the laboratory, of the behaviour of the soil towards these manures, as seen in properly arranged field experiments. For various reasons the obvious method of determining the proportions of Nitrogen, Phosphoric Acid, and Potash in the soil fails in many cases to give the required information; even the more modern methods of measuring only the quantities of these materials which are attacked by weak acid solvents, and in consequence regarded as available to the plant, by no means always accord with the results of experience. Hence from time to time attempts have been made to attack the problem from another side and to use the living plant as an analytical agent. The scheme is to take a particular plant grown upon the soil in question, and determine in its ash the proportions of constituents like phosphoric acid and potash. Any deviations from the normal in these proportions may then be taken as indicating deficiency or excess of the same constituent in the soil and therefore the need or otherwise of specific manuring in that direction. The theory rests on two assumptions, first that each plant has a typical ash composition, constant when the plant is grown under similar conditions; secondly that the variations in the proportion of such a constituent as phosphoric acid will reflect the amount of that plant food available in the soil, as measured by the response of the crop to phosphatic manuring. . . . . . .

*From *The Journal of Agricultural Science,* Vol. I, Pt. 1, Jan. 1905.

After setting out in detail numerous analyses made and the results obtained, Prof. Hall comes to the following general conclusions :—

1. The proportion of phosphoric acid and of potash in the ash of any given plant varies with the amount of these substances available in the soil, as measured by the response of the crops to phosphatic or potassic manures respectively.

2. The extent of the variation due to this cause is limited, and is often no greater than the variations due to season, or than the other variations induced by differences in the supply of non-essential ash constituents—soda, lime, &c.

3. The fluctuations in the composition of the ash are reduced to a minimum in the case of organs of plants, which, like the grain of cereals, or the tubers of potatoes, are manufactured by the plant from materials previously assimilated.

4. The composition of the ash of the cereals is less affected by changes in the composition of the soil than is that of root crops like swedes and mangels.

5. The composition of the ash of mangels grown without manure on a particular soil gives a valuable indication of the requirements of the soil for potash manuring. Similarly the phosphoric acid requirements are well indicated by the composition of the ash of unmanured swedes, though in this case determination of the citric acid soluble phosphoric acid in the soil gives even more decisive information.

6. Pending the determination of phosphoric acid and potash "constants" for some test plant occurring naturally on unmanured land the interpretation of soil conditions from analyses of plant ashes is not a practicable method by which chemical analyses of the soil can be displaced.

GRANTS OF LANDS BY CROMWELL TO SETTLERS IN JAMAICA.

Colonial Secretary's Office,
5th March, 1907.

Circular.
No. 13599/06.

Sir,

I am directed to forward to you the enclosed copy of a Proclamation by the Lord Protector Cromwell dated 10th October, 1655, regulating grants of Land to settlers in Jamaica, and I am to ask that you will have this sheet secured at the first page of the first volume of the Revised Statutes of Jamaica in your office, as a matter of public interest in connexion with the Colony.

I have the honour to be,
Sir,
Your obedient Servant,
H. CLARENCE BOURNE,
Colonial Secretary.

The Director of Public Gardens
and Plantations, Kingston.

Proclamation of the Lord Protector Oliver Cromwell.

ORDER BOOK OF THE COUNCIL OF STATE.

21 August, 1654, to 14 February, 1655-6.

[State Papers, Domestic Series, Interregnum, Vol. I 76A. page 152].
Passed by his Higs. & ye Councell, 10 Oct. 1655.

O. P. By the Protector

A Proclamation giveing encouragement to such as shall transplant themselves to Jamaica.

WHEREAS the Island of Jamaica in America, is by the Providence of God in the hands and possession of this State the enemy which was found upon it, being fled into the mountaines with an intention to escape into other partes save such of them as do daily render themselves to our Comaunder in Cheife there to be disposed of by him and Wee being satisfied of the goodness fertility and commodiousness for trade and comerce of that Island have resolved by the blessing of God to use our best endeavors to secure and plant the same for which end and purpose Wee have thought it necessary to publish and make knowne unto the people of this Comonwealth and especially to those of the English Islands Plantacons and Colonies in America Our Resolutions and intencons on that behalfe as also to declare unto them the encouragemte which Wee have thought fitt to give unto such as shall remove themselves and their habitations into the aforesaid Island of Jamaica within the time menconed and expressed in these presents And first concerning the secureing thereof against the enemy Wee have already upon the Island which landed there in May last above Six thousand souldiers and the begining of July after Wee sent from hence A Regiment of eight hundred more drawne out of Our old Regiments in England with eight Shipps of Warr besides victuallars to be added to twelve others that were left there by Generall Penn under the comaund of Captaine William Goodson all which are appointed to remaine in those seas for the defence of the said Island and Wee shall from tyme to tyme take care to send thither other both land and sea forces that Wee may have alwaies in those parts such a strength as may be able through the blessing of God to defend and secure it against any attempt of the enemy that whereas the Planters in other places have been at great and vast expences at their first sitting downe and in the very begining of their plantacons for their necessary defence as well against the natives of the countrey as other enemyes : Those who shall remove thither wilbe under the imediate protection of this State and so eased both of the danger and charge which other plantations are subject to and shall have for their further encouragemt the termes and conditions following :

1. Those who shall transport themselves as aforesaid shall have land set forth unto them according to the proportion of Twenty acres besides lakes and rivers for every male of twelve yeares old and upwards and ten acres for every other male or female in some convenient place of the said Island and in case any whole Plantation That is to say the Governors and greatest part of ye people shall remove themselves they shalbe preferred in respect of their place of sitting downe that it may be neare some good harbour commodious for commerce and navigation./.

2. That the said proportion of land shalbe set forth unto them within six weekes after notice given by them under their hands or the hands of some of them on the behalfe of the rest unto His Highnes Comaunder in Chife or Com[s] there appointed for that purpose of their resolutions to remove and of the tyme they intend to be upon the place./.

3. That they shall have libertie for the space of seaven yeares to hunt take and dispose of to their owne use such horses and other cattle as are or shalbe upon the said Island the same not being marked by or belonging to other planters: subject neverthelesse to such rules and directions as to their hunting and takeing of horses cattle and other beasts out of their owne bounds and limitts as shall from time to time be made by the persons authorized by His Highnes for manageing the affaires of the said Island./.

4. That they shall hold the said land with all howses edifices woods trees proffitts and advantages thereupon to them and their heires forever to bee held in free and comon soccage without any rent for the first seven yeares and then one penny an acre and by noe other rent tenure or service whatsoever./.

5. That after the said proportions of land are sett forth as aforesaid His Highnes or his successors upon the desire of the owners thereof shall by Letters Pattents under the Great Seale of England or by such other sure waies as shalbe divised by their councell learned in the law give graunt and confirme unto him or them their heires and assignes the said proporcons of land together with all and singular the priviledges jurisdictions profftts and advantages which are intended hereby to be enioyed by them with power to erect and create any mannor or mannors with tenures in free and comon soccage within such plantacon and plantacons as shalbe capeable thereof./.

6. That they shall hould and enioy all and singular mines of copper iron tinn and other mineralls whatsoever excepting (gould and silver mines) and all mines of quaries, coale, stone allum or other mines whatsoever (except as aforesaid) within the circuite meetes or bounds of the said severalle respective proportions of land and also all fishings and piscaries whatsoever upon or within any of the lakes streames or rivers within their meetes and bounds and also full power and authoritie to man and send forth to sea and unto any the coasts and shoares roades harbo[rs] and creekes within or neere the said Island any shipps boates or other vessells to fish for find out or take any pearles, precious stones or jewells therein being and to enjoy the same to his or theire owne use or uses rendring and payeing to the Governor of the said Island for the tyme being or to such other person or persons for the tyme being as His Highnes shall authorize to receive the same to His Highnes use the full fift part only and noe more of all such pearles precious stones and jewells as shalbe gost found and taken as aforesaid and also one tenth part of all such mettall as shalbe had found and gianed in the mines graunted hereby to the aforesaid planters./.

7. That noe custome excise impost or other dutie shalbe set or imposed for the space of three yeares to be accompted from the 29th of Septemb[r] w[ch] shalbe in the yeare of our Lord 1656 upon any of their goods & merchandizes of the growth pduction or manufacture of the said Island which they shall transport into this Comonwealth nor shall

they or their serv[ts] without their owne consent be drawn out into the warrs unles it be in case of invasion or rebellion and for the defence of the Island./.

8. That they shall have power to build wales and raise bulwarks and castles upon their owne land for the defence and securitie of their owne plantacons and also to arme themselves and serv[ts] and to lead and conduct them against any enemies or rebells within the said Island subject neverthelesse to such orders and directions as they shall in this behalfe receive from the Governo[r] or Comaunder in Cheife of the said Island for y[e] time being./.

9. That all and every person and persons that shall hereafter happen to be borne within the said Island shalbe and shalbe deemed and accounted to be free denizens of England and shall have and enjoy all and every such benefitte priviledges advantages and imunities whatsoever as any the natives or people of England borne in England now have and enjoy in England./.

That all such professing the Protestant Religion who shall transport themselves into the aforesaid Island within two yeares to be accounted from the said 29 day of September 1656 and shall make a begining therein by transporting to the said Island one third part of their number before the nine and twentieth day of September next shall have and enjoy the aforesaid priviledges and advantages; and for the more certaine carryeing on of this busines and answereing our intentions herein Wee doe hereby authorize and require our Comaunder in Cheife of the said Island for the time being and also the aforesaid Com[rs] that they take notice of the premisses and cause a due and effectuall execution of the same from tyme to tyme as their shalbe occasion according to the purport and true meaning hereof for which these presents shalbe their sufficient warrant. Given at Whitehall the tenth of October 1655./.

I certify that the foregoing is a true and authentic copy.

J. S. HANDCOCK,
Assist Keeper of the Public Records.

12th November, 1906.

SUPPLEMENT TO BULLETIN.

A Supplement to the Bulletin will shortly be published containing a list of the Sedges of Jamaica by Dr. N. L. Britton, Director-in-Chief of the New York Botanical Garden.

As this list is only of interest to those who are studying the botany of Jamaica, a limited number of copies will be printed, and only supplied to those who specially apply for it.

BOARD OF AGRICULTURE.

EXTRACTS FROM MINUTES.

The usual monthly Meeting of the Board of Agriculture was held at Headquarter House on Wednesday 17th April, at 2 p.m.; present: Hon. H. Clarence Bourne, Colonial Secretary, Chairman; the Director of Public Gardens, the Island Chemist and the Secretary.

Hand Cotton Gin—The Secretary reported that one of the Hand Cotton Gins had been overhauled at the Railway Workshop, and, after testing it, he had delivered it to Mr. Desporte who was now ginning his cotton. He reported that Mr. Desporte was so pleased with the results of his trial acre—which had been visited by Sir Alfred Jones and Sir Daniel Morris—and the price of the samples sent to England had been so satisfactory, viz.: 1/7 to 1/9 per lb. that he was going to England to make arrangements for putting in a large acreage in the month of August in the most careful and cautious manner, taking advantage of all previous experience.

Appointment of Mr. Conrad Watson to Board—The Chairman intimated that the Governor had appointed Mr. Conrad Watson, Attorney for the Earl of Dudley, as a member of the Board in the room of the late Mr. Middleton.

The Secretary read the following letters from the Colonial Secretary's Office.

Arrowroot—1. Re arrowroot, referring to previous correspondence in September and October 1906, and asking whether he was now in a position to secure a regular supply of arrowroot at not more than 2½d. per lb.

The Secretary reported that he had written to all the districts where arrowroot was grown and he had found that Lamb's River could supply 400 lbs. at 20/ per 100 lbs., barrels, cartage and railway freight extra. He accordingly advised the Colonial Secretary and asked to be informed as early as possible if this supply could be taken so as to encourage local trade, but he had not yet had a reply.

Importation of Seeds and Plants—2. Re importation of Seeds and Plants, stating that it had been suggested by the Director of Public Gardens that in view of the importance of getting Rubber seeds from Ceylon, the Proclamation of 2nd December, 1887, prohibiting the importation into this Island of seeds or plants from Natal, South India. Ceylon, Mauritius, Java and Fiji should be withdrawn, and asking for the views of the Board. The Coffee planters in the Blue Mountains had been consulted, and agreed that there was no risk now. It was decided to recommend that the Proclamation be withdrawn as regards all seeds or plants with the exception of coffee plants and coffee seeds.

Cotton Machinery—3. Re Cotton Machinery, referring letter from Sir Daniel Morris enclosing copy of letter from the Secretary of the British Cotton-growing Association stating that the Association was agreeable, under certain conditions, to transfer to Lord Dudley's Agent all the Cotton Machinery loaned by the Association to the Government of Jamaica in order to start the Cotton Factory to be erected at New Yarmouth Estate.

The Secretary reported that in connection with the ginning of Mr. Desporte's cotton he had already written Mr. Sharp for a report on the Steam Gin which he had the loan of, and there were also four Hand Gins, but he pointed out that all had been presented to the Government as gifts,and were not loaned, as shown by letters from the Secretary of the British Cotton-growing Association to the Colonial Secretary in April 1903 and July 1904.

The Secretary submitted letter from T. V. Hayes, Edna, Texas. asking if two or three Brahmin Bulls could be sent him.

The Secretary stated that the Leyland Line did not care to take freight to New Orleans in case the cattle should be refused admittance at that place and he had written Mr. Hayes to make enquiry first whether they could be landed at New Orleans.

Chemist's Reports—The Secretary submitted the Chemist's Reports as follows :—

1. Examiner's Report on Diploma Examination 1906. This was read and considered satisfactory, all the candidates being successful. It was agreed to print the report in the "Bulletin" and that the class list be inserted in the Gazette as formerly.
2. Necessity of suspending Agricultural Course until January 1908, reporting that this was necessary owing to earthquake damage at Hope. Also that three Scholarships should be provided for next year and that Mr. Wortley should occupy his time normally devoted to this course, to general assistance in this Department.

This was agreed to.

Reports from Director Public Gardens—The following Reports from the Director of Public Gardens were submitted :—

1. Instructors.
2. Hope Experiment Station.
3. Letter from Mr. Cradwick re his removal, asking if he could be allowed to make his home meantime in Mandeville and that he be allowed to go there once a fortnight as it was difficult to find a home in St. Mary or Portland, the extra expense incurred in travelling to Mandeville to be borne by himself, his travelling expenses to be calculated from Richmond or Spanish Town.

It was agreed that the expenses should be taken from Richmond as the centre and that the permission asked for be granted.

The usual monthly Meeting of the Board of Agriculture was held on 15th May ; present :—Hon. H. Clarence Bourne, Chairman ; the Director of Public Gardens, the Island Chemist, the Superintending Inspector of Schools ; Messrs. C. E. deMercado, G. D. Murray, Conrad Watson and the Secretary.

As matters arising out of the Minutes, the Secretary read the following :—

Cotton Gin—1. Letter from Mr. T. H. Sharp with regard to the Steam Cotton Gin loaned to him, in which he stated that he had the Gin and Baler in his Ginnery to order of the Board, that he was sending away 50 bales of fine Cotton in April, and that no worms had troubled the cotton this season.

Mr. Conrad Watson said that this Steam Gin being a double action one would not be suitable for his purpose. He preferred a single action one for long staple cotton.

It was suggested that the Gin might come in useful for Mr. Desporte's Cotton venture next season and that in the meantime it could stay with Mr. Sharp.

Arrowroot—2. Letter from the Colonial Secretary's Office enclosing copy of letter sent to the Superintending Medical Officer with regard to local supply of arrowroot, saying that it was His Excellency Sir J. Alexander Swettenham's wish that local factories should be encouraged if, and when, they are able to supply the Government on equal or better terms than importers, and that he relied on him to arrange for this in the case of arrowroot; and sending copy of memorandum from the Secretary of the Board of Agriculture on the subject for his information and guidance.

The Secretary was asked not to lose sight of the matter, so that the public institutions should be supplied.

Veterinary Surgeon—The Secretary read letter from an applicant re appointment as Government Veterinary Surgeon offering his services should the vacancy of Government Inspector occur.

The Chairman stated that on the death of Mr. R. Rain who had been appointed Acting Government Inspector of Stock on the death of Dr. Gibb in the earthquake, the Government had appointed Mr. Tavares to act as Inspector.

As the matter of the appointment of a Veterinary Surgeon subsidised by the Government was under discussion by the Agricultural Society, the Secretary was directed simply to acknowledge the applicant's letter. It was thought that penkeepers ought to subsidise a Veterinary Surgeon in the same way that sugar estates retained engineers, rather than that a Government appointment should be made.

Chemist's Reports—The following Reports from the Chemist were submitted and directed to be circulated :—

1. Appropriation Accounts, Government Laboratory, 1906-7.
2. Appropriation Accounts Board of Agriculture Deposits, 1906-07.

Director Public Gardens Reports—The following Reports from the Director of Public Gardens were submitted :—

1. Hope Experiment Station.
2. Instructors.

Vanilla—The Director of Public Gardens also submitted a letter on the vanilla industry in North Westmoreland from Mr. A. B. Ventresse, sent to him by the Chairman for his remarks, the purport of which letter was that Mr. Cradwick had encouraged the planting of vanilla there where it grew easily and there were now about 10,000 pods maturing but the people did not know how to cure them for commercial purposes, and asking that Mr. Cradwick might be sent up there for a time to instruct them.

After discussion it was resolved that as Mr. Cradwick had only lately been transferred to St. Mary, St. Catherine and Portland in connection with the cocoa industry, it would be unwise to alter his itinerary.

The Secretary was instructed to write to a resident in the neighbourhood who was said to take great interest in vanilla, and the Instructor for the Western District, to find out what they could do in the matter.

Cocoa—The Director of Public Gardens also submitted reports from Mr. Cradwick (a) on cocoa trees dying in Islington and other districts in St. Mary, (b) on investigation of the disease of cocoa pods known as "Black Tip." The Director stated that the diseases had been investigated already and remedies pointed out, and that notes on the subject had been published in the Bulletin for Dec., 1905 and Jan. 1906.

The Papers were directed to be circulated and published thereafter.

The following papers which had been circulated but had not yet been before the Board were submitted :—

Concentrated Rum—1. Papers from the Colonial Secretary's Office with letter from Hon. J. V. Calder re Concentrated Rum, and Memo. from the Island Chemist.

Mr. Cradwick's Home—2. Letter from Director Public Gardens with letter from Mr. Cradwick re arrangements about his home.

As this matter had already been discussed and settled no remarks were made on the papers.

The following papers which had been circulated were submitted for final consideration :—

1. Mr. Cradwick's Reports.
2. Mr. Briscoe's Reports,

The Secretary read a paragraph from Mr. Briscoe's Reports stating that the cane said to be D. 95, grown at Albion Estate was not that variety, with the Chemist's note that this was D. 135, which seemed to suit the conditions of Albion.

3. Report on Hope Experiment Station.

[Issued 9th July, 1907.]

Printed at the Govt. Printing Office, Kingston, Jam.

BULLETIN

OF THE

DEPARTMENT OF AGRICULTURE.

Vol. V. JUNE & JULY, 1907. Parts 6 & 7.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.,

Director of Public Gardens and Plantations.

CONTENTS:

PRICE—Sixpence.

A Copy will be supplied free to any Resident in Jamaica, who will send name and address to the Director of Public Gardens and Plantations, Kingston P.O.

KINGSTON, JAMAICA:
HOPE GARDENS.

1907.

JAMAICA.

BULLETIN

OF THE

DEPARTMENT OF AGRICULTURE.

Vol. V. JUNE & JULY, 1907. Parts 6 & 7.

COCO-NUT PALM DISEASE IN TRINIDAD.

The Commissioner of the Imperial Department of Agriculture for the West Indies to the Director of Public Gardens and Plantations, Jamaica.

Imperial Department of Agriculture for the West Indies.

Barbados, April 9, 1907.

My dear Fawcett,

In view of the investigations that are being conducted with reference to the "bud-rot" disease of the coco-nut, I enclose, herewith, for your information, a copy of a report, published in the Trinidad *Royal Gazette* of February 7 last, by Mr. F. A. Stockdale, B.A., the Mycologist on the staff of this Department, on the inquiry into the causes of the diseases of coco-nut palms in Trinidad during his visit to that Colony in July and August last.

The three diseases described are as follows:—

(1) a root disease; (2) a leaf disease; and (3) a "bud-rot" disease; and as it is probable that similar diseases may occur amongst coco-nut palms in Jamaica, the recommendations and suggested remedial measures may be of value in affording information as to the best means of preventing the further spread of diseases.

A summary of this report has already appeared in the *Agricultural News* (Vol. VI, p. 75) with a view to directing the attention of coco-nut planters to diseases amongst their cultivations.

With kind wishes,

Sincerely yours,

D. MORRIS.

COCO-NUT PALM DISEASE.

The Mycologist to the Imperial Commissioner of Agriculture.

BARBADOS,

19th October, 1906.

SIR,

I have the honour to submit, herewith, a report on my visit to Trinidad from July 10th to August 14th to inquire into the causes of the disease of the coco-nut palm which was reported to be prevalent among the coco-nut plantations in that island, and to suggest, if possible, remedial measures.

2. Leaving Barbados on July 10th, I reported immediately on my arrival in Port-of-Spain to the acting Colonial Secretary. After examining the coco-nut trees around Port-of-Spain at Cocorite and Laventille I proceeded to Cedros, where the disease was reported to be causing the most damage. There my head-quarters were made, and a small laboratory for the experimental investigation of diseased material was established. From Cedros, I visited practically all the coco-nut districts of the island, inspecting in all some twenty-nine estates besides many peasant properties. I was, therefore, able to examine trees receiving different degrees of cultivation, etc., growing under varying conditions of soil and climate, and to obtain a fairly accurate idea of the economic importance of the diseases under investigation.

3. During my stay in Trinidad, I received every possible attention and assistance from the officials of the Colony, and also from the planters, who afforded me every facility for carrying out my investigations. I, therefore, take this opportunity of tendering my thanks for the assistance I received from everyone, and more especially to Mr. J. H. Hart, F.L.S., the Superintendent of the Royal Botanic Gardens, for many valuable suggestions and for the use of his laboratory at the St. Clair Experiment Station, and to Mrs. Greig and the manager in charge of the estates owned by W. Greig, Esq., in the Cedros district for their kindness in affording ready means of transportation through the southern extremity of the island.

4. The coco-nut thrives best on a thoroughly permeable soil, from which it can obtain a copious supply of water, and it is doubtless for this reason that the rich permeable, well-drained alluvial soils which generally border on the sea shore are held to be the best suited for successful cultivation. It would, however, appear that soil conditions are of far greater importance to the growth of the coco-nut than the exposure to sea breezes, for the amount of water present in the roots of the coco-nut palm show that a large supply of this fluid is necessary.

5. It is estimated that 14,000 acres were under coco-nut cultivation in Trinidad in 1902,* but the recent improvement in the prices for coco-nuts and their products has induced more planting to be done. A much larger acreage is now devoted to their cultivation.

6. The chief coco-nut districts in Trinidad are the Cedros and Icacos districts which form the south-western portion of the island, the coast line between Manzanilla and the Galeota points on the East Coast where the plantations are contiguous (referred to in this report as the Mayaro district) and parts of the coast line between La Brea and Cedros points on the West Coast known as the La Brea and Oropuche district.† There are besides a few

* *West Indian Bulletin* Vol. vi., p. 149.

† The southernmost portion of this district is referred to in this report as the Guapo District.

isolated plantations on the North known as the Toco district, and a few around Port-of-Spain at Cocorite and at Laventille.

7. Visits were made to all the districts except Toco where, the conditions were reported as being similar to those in some parts of Mayaro.

8. It was observed that soil conditions in most cases were fairly favourable, although much more could be done in the matter of systematic drainage and careful cultivation. Reference, however, will be made to different conditions later.

9. From the above, it will be seen that the coco-nut industry of Trinidad is one of great importance and therefore it is reasonable to expect that any disease or diseases of the coco-nut palms, that are likely to become widely distributed, should cause considerable anxiety, especially when it was reported that of 25,000 trees on one plantation in the Cedros district over 3,000 trees have been destroyed within the last twelve months and many more were showing signs of disease.

10. During the inquiry, three distinct diseases of coco-nuts were found, two of which are apparently due to the attacks of fungi, and one, until further information can be obtained, must be said to be of bacterial origin. One fungus attacks the roots and appears also in the petioles, and for convenience of identification the disease caused by it will be referred to as the 'Root disease.' The other fungus attacks the leaves, and this disease will be described as the 'Leaf disease.' The bacteria on the other hand give rise to rotting of the terminal bud and this will be spoken of as the 'Bud-rot.'

11. Besides these diseases, insect attacks were noticed on three estates—a scale insect attack on the leaves on an estate in Mayaro district, a beetle attack on an estate in La Brea district and locusts on an estate at Icacos. My chief object at present is to submit a short and simple account of the diseases that have been investigated and to suggest remedial measures as far as possible.

12. It has been found necessary to introduce certain scientific terms in the body of this report but the wording has been as simple as possible. In order that the destruction caused by fungi may be more clearly understood. it should be pointed out that fungi can roughly be classed into three groups:—(1) Forms which live only on living plants and animals (parasites): (2) Forms which live only on dead vegetable or animal matter (saprophytes), and (3) Forms which live on either dead matter or on living plants or animals (facultative parasites). Some of the fungi mentioned as attacking coco-nuts belong to this latter class and whereas the living plant must be looked upon as a machine, (and any fungus that is capable of attacking and killing its roots, must reduce the amount of water and food taken up by the plant from the soil. and any fungus, that kills leaf tissues, must upset the normal functions of the leaves), it is apparent that by continued action parasitic fungi on a healthy plant interfere with the normal physiology of the plant and ultimately cause its death, while the presence of large heaps of diseased material on a plantation may

tend to further propagate the fungus. Disease is an extremely complex phenomenon, involving many reactions and interactions between the plant and its evironment and, therefore, every disturbance of functional equilibrium has to be carefully considered before any definite conclusions can be arrived at. In this report every consideration has been given to the results of practical experiments and the soil and climatic conditions of the different localities in order that the *pros and cons* should be carefully weighed before any remedial measures are suggested.

Section I.—ROOT DISEASE.

13. An attack of this disease is generally first shown by the leaves. They show a slightly wilted appearance, then turn yellow, first at the tips and then gradually all over the leaflets. These dry up, blacken, hang down from the 'cabbage', and often remain for a considarable time before they are shed,—a badly attacked palm often being entirely enclosed in numbers of leaves around its trunk. Frequently, however, it is noticed that the leaves do not hang down around the trunk but the petioles break across, leaving the sheathing portion on the trunk, while the foliage portions of the leaves have fallen to the ground. Sometimes the petiole does not completely break and the foliage portion of the leaves hangs vertically downwards, attached to the portion of the petiole that is left attached to the stem.

The outer leaves are sometimes those that show signs of wilting and yellowing first but this is not always so, for frequently palms may be noticed in which a 'middle' ring of leaves becomes wilted and yellow while rings of green leaves remain above and below.

After the yellowing of the leaves, trees bearing a good crop of nuts as a rule gradually shed most if not all of them, irrespective of their size and state of development, and the flowers subsequently produced do not set. In fact, it is possible for a person to pick out with certainty trees that are diseased before any yellowing of the leaves is noticed, by carefully looking at the condition of the leaves and at the latest flowers that are being put forward. Any trees that are diseased can at once be singled out. The local conditions of the soil must be considered before a tree is definitely stated to be diseased as the whole appearance of the diseased trees suggests a lack of water, and therefore may be confused with trees that are suffering from this cause alone in drought-affected areas.

An increased supply of water, either natural or artificial, will improve the condition of drought-affected trees but the wilted appearance of diseased trees, although it may be slightly less noticeable, is more permanent, and the symptoms do not disappear.

After a number of the leaves have yellowed and died, it is only a question of time before the terminal bud falls over and becomes a putrid mass,* and the palm eventually dies, as it has no power of branching or of producing a new growing point.

14. Trees which only present external signs of disease to the experienced observer show that apparently the roots are probably the parts which become first affected. After a considerable number of these have been rendered useless in contributing to the life of the plant, changes take place which result in a sour-smelling red discoloration in the stem that probably commences at the level of the ground and extends upwards.

The position of this red discoloration would appear to vary in the stem directly with the roots that are affected, and it has been repeatedly noticed that when a 'middle' ring of leaves shows signs of yellowing, the discoloration is found towards the centre, while if the lowest leaves become wilted, the stem presents a ring of discoloration towards the outside of the stem. The petioles also show that they are infested with the mycellium of a fungus for when the leaves become dry and hang down the fructifications push through the epidermis and form pustules of varying size and shape. Eventually, when the vitality of the tree has been reduced, the terminal bud as already noticed becomes infested with a 'rot' which causes the whole cabbage to fall over, resulting in the death of the tree.

15. Specimens of leaves, roots, stems, petioles, &c.. were taken from a considerable number of diseased trees for examination and for cultural and infection experiments. Although it has been impossible to establish with certainty the whole of the life history of the fungus in the short time that has been given to the study of this disease, yet some interesting points have been established.

ROOTS.—Section of a healthy root shows that on the outside, there is a kind of skin to the root, formed of thick-walled cells, and within this outer layer may be noticed two regions very definitely marked off from each other—the inner is the *central cylinder* and the outer the *cortex*. The cells of the central cylinder are of different kinds. The larger of these are thick-walled and are arranged in bundles. They form tubes throughout the length of the roots and are continuous with similar 'vessels' in the stem and leaves. It will be noticed that this portion of the root is hard, for the walls of the cells are lignified and serve for the maintenance of the shape of the root, and also for the transference of water and food in solution from the root to the stem and leaves. Around these vessels are packed numerous thin-walled cells and fibres. The cortex is composed of thin-walled cells loosely arranged. They are uniform in shape and contain a lining of protoplasm—living matter—and also a large quantity of water. It is the contents of these cells that keep them rigid and make them pack closely together.

Microscopic examination of diseased roots was made in longi-

* When a coco-nut palm is affected by any disease or pest, the terminal bud, in the advanced stages, becomes involved in a rot. This must not be confused with 'bud-rot' which appears to be a specific disease, as the roots, stem and leaves are sound, while the bud is in a diseased condition.

tudinal and transverse sections. At once it was noticed that the cortex of the roots was abnormal.

In a diseased root, the walls of the cortex cells appear to be shrunken and the cells are turgid no longer. Between the walls of consecutive cells can be seen large dark-coloured septate threads of a fungus mycelium,* while many of the cells themselves have become invaded by the same. When a cortex cell is threatened by the approach of a fungal thread, its cell contents appear to be altered, for large yellowish globules make their appearance. Whether these have been produced by the cell itself as a means of protection against the fungus, or whether they are the result of decomposition could not be determined, but after the mycelium has gained an entrance into the cell, these globules as well as all the other cell contents, are destroyed and absorbed.

The mycelium of the fungus spreads from one cell to another by piercing through the cell walls, and soon obtains an entrance into the thin-walled cells of the central cylinder and eventually into the vessels themselves.

The red discoloration of the stem was carefully examined microscopically but except in the case of trees that were very badly diseased, few mycelial threads could be detected. These in the advanced cases were similar to those noted in the roots, but I am of opinion that the red discoloration is primarily due to the disorganization of normal changes in the stem through the stoppage of supplies from the roots, rather than to any effect of the small amount of fungal mycelium found in diseased stems.

PETIOLES.—It was observed that almost without exception, the petioles of the leaves of badly diseased trees showed a large number of minute ruptures of the epidermis, after they had died and had fallen to the ground. The petioles in varying stages of disease were therefore submitted to a careful microscopic examination and it was observed that a mycelium of a fungus was found in all diseased petioles.

The point of the first attack could not be determined, but it would appear that the petiole, just where it expands to ensheath the stem of the tree, is the part where the effect of the fungus is first noticed. The whole petiole gradually assumes a blackish colour, the leaflets become brown, and eventually on the dead petioles minute ruptures take place in the epidermis of the petiole just where it begins to expand before joining the stem. These give off a black powdery dust, which consists of spores of two kinds—one, single-celled and colourless, and the other two-celled and brown.

16. The two-celled spores suggested that the fungus belonged to the genus *Botryodiplodia* and therefore specimens were forwarded to Dr. N. Patouillard, who has recently described several new specimens of fungi on coco-nuts from French Polynesia, for identification and he reports as follows :—

*The mycelium of a fungus is made up of minute threads or filaments and may be looked upon to bear a similar relation to a whole fungus as the roots of a coco-nut bear to the whole palm.

'I have examined the specimens of parasitic fungi on petioles of coco-nut.

The epidermis is raised and split up but covers the fungus. Out of the slit, a black powder which is formed of brown uniseptate spores protrudes. If a section is made through the wart-like pustules, there is found under the skin a black cellular stroma, filled with several lockets. These spaces are filled with colourless nonseptate spores. If these are placed in a damp chamber, in about 24–36 hours, germination takes place. The colourless spores are therefore adult and mature. If we consider the fungus in respect to its hyaline spores it must be considered a *Cystospora* (a large genus) or better a *Fusicoccum.*

If the brown septate spores really belong to it and are the final end of the development, the fungus will be a *Botryodiplodia.* It remains then to establish that these last belong to the fungus. It is very probable but not proved.'

In working out the life history of the fungus it has frequently been noticed that the colourless spores become brownish in colour and afterwards become septate. Considering that no difference can be noted in the mycelia produced by the two fungi, that the wart-like pustules bear both kinds of spores, and that the colourless cells have been observed to be dividing by a single septum, I am of opinion that there is sufficient evidence to conclude that the septate, brown spores are the final results, (the colourless unicellular cells being the forerunners) and that therefore the fungus must be considered as a species of *Botryodiplodia.*

17. The damage caused by the fungus in the roots of the disorganisation of the cortex cells has been observed and therefore the effect this has on the coco-nut plant may clearly be understood. The roots of a healthy plant conduct the water and food in solution from the soil to the leaves, and therefore, when the fungus has destroyed a large number of roots, a reduction in the water-absorbing power of the root system takes place. There are, however, few economic plants that so quickly repair damage to roots as the Palmæ, and, therefore, the seat of the injury must extend through a large number of roots before it is of any consequence.

When a large number of roots are diseased, the water, etc., is absorbed in gradually decreasing quantities, and consequently less food substances are elaborated.

Young trees do not appear to suffer to any considerable extent for numerous instances have been noticed of young plants having quite a healthy appearance while a number of the roots were in a diseased condition.

When, however, the fruiting period comes on, a large drain is made upon the tree. It is taxed very highly and, if the roots are diseased, wilting or yellowing of the leaves is noticed. It was observed that trees that were just coming into bearing were the most liable to succumb, although many old trees were in a diseased condition.

When the root system, reduced in extent by the action of the fungus, is incapable of supplying the needs of the plant, the leaves commence to roll up, so as to reduce evaporation. Subsequently the leaves do not obtain sufficient water to keep their tissues alive and then they gradually begin to turn yellow and to dry up, the leaves are, therefore, unable to carry on their functions and the whole mechanism is thrown out of action. The general appearance of the plant is that of one suffering from 'drought.'

The petioles of the leaves are also filled with fungus mycelium. This may be noticed in all dying leaves, for their petioles are blackish in colour. No instance has been found of the mycelium passing from the petioles into the stems of the trees, and if a section be cut through a terminal bud of a freshly diseased tree, a sharp line of demarcation will be noticed between the diseased petioles and the healthy bud. This mycelium cuts off much food to and from the leaf and therefore assists in the general disorganization of the functions of several parts of the plant.

The reasons for attributing the damage to fungus in the roots are as follows :—

(1.) The external symptoms of the disease suggest lack of water.

(2.) The roots of all trees examined were in a diseased condition through the presence of a fungus.

(3.) Some instances were noticed in which the roots of dead or dying trees were diseased while no fungal mycelium could be detected in the petioles.

(4.) As a rule several leaves begin to become wilted and yellow at the same time, whereas if the fungus in the petioles were the primary cause of the trouble, it would be expected that first one leaf and then another, and not a considerable number at once would become attacked and die.

(5.) The red rim of discoloration in the stem which generally begins at the base of the tree first and then spreads upwards is closely associated with the death of the roots and the wilting of the leaves, but it is often noticed in the stem before the leaves turn yellow and before any fungus can be noted in the petioles. It would appear therefore that the discoloration in the stem should be attributed to the stoppage of water supply from below rather than to disorganization produced by cutting off of manufactured food supplies by the leaves.

18. The general opinion of the planters of coco-nuts was that this disease is due to the weakness of the plants produced by the setting of immature nuts. In some districts histories of weather beaten cargoes of green nuts been driven on the shores and the nuts used for planting purposes were held out as the cause of the trouble. This disease however is not limited to a few scattered trees, and evidence distinctly points to its being infectious. A

tree that has become attacked by the disease is sooner or later surrounded by a large number of others showing signs of the disease. In one portion of the Cedros district, the disease has been noticed making its way gradually into other fields of coco-nuts further south. It is, therefore, impossible to believe that the large areas of coco-nuts in Cocorite, Laventille, Guapo, Cedros, and the interlands of Mayaro were planted with immature nuts.

Moreover, the fungus found in the roots and in the petioles of diseased trees is capable of attacking vigorous trees; but anything which tended to reduce their vitality would considerably help along the fungus. Circumstances which retard growth, both of the root and shoot system, give the root fungus a much better chance. This was conspicuously brought to my notice on a portion of an estate in the Cedros district. A low-lying hollow showed that a large quantity of water was present in the soil. Such a condition was unfavourable to good development of the trees: they were stunted in growth and showed that root development was not very large. The clayey impervious nature of the soil suggested that an elaborate system of drainage was needed in order to procure the aeration necessary for vigorous plant growth. In this hollow most of the trees had died out very rapidly and the disease had soon spread from this portion of the estate to other parts where the soil conditions were much more favourable. Trees on sandy soil on higher ridges were often noticed to be attacked, but it is generally in low-lying undrained hollows that the disease is the worst. This is also seen in the Guapo and Mayaro districts.

These examples should suffice to show how natural peculiarities of an estate and other physical features affect the disease, but these alone cannot be sufficient to cause the death of the trees, as is often urged. The characters of the soil affect the growth of the plant and they may also affect the fungus and therefore it is necessary to keep the condition of the soil as good as possible, in order that it may be favourable to the growth of the plant.

It is also commonly stated that lack of cultivation and manuring is the cause of the trouble, and it should not be forgotten that every effort to improve the condition of the soil and render it better adapted to the healthy and vigorous growth of the root system may be a blow at the fungus, for some of the new roots would certainly go to replace those destroyed by the parasite.

The presence of a parasitic fungus in the roots and in the petioles must, therefore, be held to be the cause of the disease and improvements in cultivation, drainage, manuring, etc., should be practised as they possibly may affect the disease indirectly by rendering the coco-nut plants more capable of withstanding its attacks.

19. The distribution of the disease may approximately be seen by looking at the map of Trinidad. The most damage appears to have been done in the Guapo and Cedros districts.

The older planters of coco-nuts seem to be familiar with the disease but, until recently, it has not been considered to be very destructive. In June, 1905, Mr. A. Busck of the United States Department of Agriculture visited the Cedros district and reported that it was a disease of a virulent character and should be taken in hand at once.

From evidence taken it would appear that the disease is at present worse in some of the smaller estates in the Guapo district, but similar conditions were noticed in some of the northernmost estates of the Cedros district. There are reasons for believing that the disease in these districts probably became prevalent, at first, in the clayey hollows of the northern Guapo district, whence it has spread southwards into the Cedros district. It would further appear that it is gradually working further south becoming first noticeable in those portions of the estates that are least favourable to coco-nut cultivation and afterwards spreading from these areas to other portions of the estates.

At Cocorite and Laventille, a large number of trees have been killed by this disease, as also have several at La Brea. In all these districts the distribution of the disease seems to have been influenced greatly by unfavourable soil conditions produced by neglected cultivation.

The interlands* of Mayaro show a fair amount of this disease, more especially in the low-lying, poorly drained clayey soils.

It has also been reported from the Toco district but as conditions there are supposed to be similar to the Mayaro district, these coco-nut estates were not visited.

In all cases the disease was found to be the more prevalent on soils of a clayey nature, especially on those that were badly drained. It occurs also on sandy soils but seems to take a longer time to destroy the tree, and I am of opinion that it has spread on to sandy areas from the clayey hollows usually present in the coco-nut districts.

In the Guapo and Cedros districts, where the disease is the worst, death of the trees appears to be very rapid. Three or four months is generally the time that intervenes between the first external symptoms to the death of the tree and usually within another three months a ring of diseased trees is noticed around the dead stump. In Mayaro the disease is much less prevalent and the death of diseased trees does not take place so rapidly, for in places where two trees are growing from the same hole, the death of the second usually takes place from 9 to 12 months after the death of the first.

The distribution of this disease appears to be fairly general throughout the coco-nut districts and considerable loss has been experienced in the southern end of the island.

20. The aggregate injury throughout the colony must be very considerable, but it is only in a few localities that serious loss has been experienced.

* This term has been applied to the lands under coco-nut cultivation some distance inland form the sea, those that are not directly on the sea-shore.

Numerous instances have been seen where diseased trees just coming into bearing have succumbed, and signs of old stumps surrounding them have been noticed. These examples would bear out the opinion of Mr. Hart that the disease has been present in the colony for a considerable time.

It is only recently that it has assumed dangerous proportions. On one estate alone in the Cedros district, out of a total of 25,000 trees, 3,000 have been cut down within the last twelve months and many more are either dead or in a diseased condition, and in many other places the disease is already a serious annoyance.

There is undoubtedly danger of further spread. This danger is emphasized by the recent rapid spread through some estates in the Cedros district and if conditions favour its development and proper remedial measures are not taken to check it, the coco-nut industry of Trinidad will materially suffer

Already some of the smaller proprietors are beginning to feel the loss of returns and this loss will be felt the more severely if the present prices for coco-nuts and their products do not hold.

21. Samples of soil from around the roots of diseased trees have been investigated microscopically, and sterile mycelium, which appeared to agree with that found inside diseased roots, was present in them. This would suggest that the mycelium is capable of spreading through the soil. This mycelium may be capable of attacking and killing the younger rootlets and then entering into the larger ones. The entry of the mycelium into the roots is still an unsolved problem, but evidence tends to show that the larger roots first show signs of infection where the smaller rootlets join them. In no case has the mycelium been noticed on the exterior of the roots and it would seem that it has to depend upon the rot of the smaller roots for its distribution.

The roots of several young supplies, that were planted upon or near to the place where diseased trees have been removed, showed on examination, the presence of a mycelium within them but not in sufficient quantities to cause their death. This indicates that infection can take place through mycelium.

It would appear to be probable that the disease may spread :—

(1.) By mycelium through the soil from root to root.

(1.) By spores blown from tree to tree.

(3.) By germinating tubes of spores from petioles attacking either the roots of the same tree or the roots of another.

(4.) By germinating "chlamydospores" from decaying petioles.

The best conditions for the germination of the spores depend upon the presence of suitable quantities of air and moisture, and the spread of the disease would be expected to be most rapid when the conditions are the most favourable. The distribution of fungus spores by wind and rain will be dealt with more fully under the leaf disease and, therefore, will not be discussed here.

The spread of mycelium in the soil depends a good deal upon the cultivation. Any condition of the soil that is unfavourable to the coco-nut may favour the root disease by hindering free root development. Excessive moisture and excessive drought may be favouring conditions for the disease. The latter cannot be remedied except by irrigation and does not appear to be a factor of any importance in this disease. The former, excessive moisture, is noticeable in many of the low-lying portions of the estates. In these hollows, the soil is often of a clayey nature—impervious to water—and, therefore, many of the air spaces between the soil particles are replaced by water. The normal working and growth of the roots is interfered with and the destruction of such roots by fungal mycelium may speedily follow. The effects of excessive moisture can be lessened by careful attention to drainage and to the mechanical condition of the soil.

The present system of cultivation of coco-nuts in Trinidad could be improved, and the attention of all growers of coco-nuts should be drawn to the progressive German colonists and to the Americans in the Philippines, where modern orchard methods are being successfully practised in the treatment of coco-nut estates, as improved cultivation would tend to retard the spread of disease.

22. Although the complete life-history of the fungus and its method of spread is not yet known with certainty, it would appear that owing to its habit in penetrating and spreading in the living tissues of the root of the host plant, cure is practically outside the question where a large majority of the roots are permeated with mycelium, and therefore it is probable that only the most drastic measures are likely to provide permanent relief.

It cannot be expected that the disease can be entirely eradicated, but, by a method of what is known as "stamping out," the amount of disease may materially be reduced and the fungus kept in check.

There are six principal ways in which we may hope to attack this disease. They are :—

(1) Destruction of all diseased material.
(2) Isolation of diseased areas.
(3) Resting of infected land before planting 'supplies'.
(4) Spraying and application of chemicals.
(5) Improved cultivation and drainage.
(6) Searching for and propagating disease-resistant varieties.

I.—DESTRUCTION OF ALL DISEASED MATERIAL.

It has been observed that diseased petioles that have fallen to to the ground often bear large numbers of spores. This would indicate that the fungus in the petioles is capable of living upon dead matter, *i.e.*, it is saprophytic during some stages of its life-history. Young supplies, planted on the place whence dead trees have been removed have also been noticed to be affected and old stumps that have been left standing have become permeated with fungal mycelium. These instances show that there is sufficient food in the form of decaying vegetable matter in old trees, etc., to continue the life of the fungus and, therefore, all dead or diseased material in an infected area should be entirely destroyed and not left to accumulate.

(*a*) All dead and dying trees should be cut down and burned whenever that is possible. When the trees contain a large amount of sap and still bear a fair number of green leaves it is almost impossible to burn, unless a number are collected and burnt in a pit after the manner of 'charcoal fires.' Otherwise these trees should be cut up and buried deeply with lime. The adoption of the burning method would probably prove to be the most effective but experience will show whether it be the most practical.

(*b*) All diseased leaves and petioles that have fallen to the ground should be collected and immediately burned on the spot.

(*c*) On no account should rubbish, such as husks, etc., be allowed to accumulate in an infected area, for this may prove beneficial to the growth of the fungus, which may continue to live on it, and thus it would form a base from which the disease can spread to living trees.

(*d*) The basal portion of the diseased trees and as many diseased roots as possible should be destroyed. It may be expensive to 'grub up' these stumps, but when it is borne in mind that the fungus can live in the old roots and is liable to attack young supplies, as well as probably to spread through the soil to healthy trees, such a destruction is necessary. An old East Indian coconut authority* holds that a large number of the roots of a coco-nut tree may be destroyed by cutting the tree near to the ground, leaving the stump for some time to dry, and then building a heap of trash and forming a fire (preferably closed by putting a thin layer of soil on the top) over the remains of the stump. In this way he states most of the roots will be destroyed, for once the fire has obtained a good hold it will travel for some distance down the roots.

There is also another danger of leaving old trees and rubbish about the plantation for they offer sufficient food for beetles, etc. which may increase rapidly and become a source of danger. An instance of this was noticed on a somewhat neglected estate in La Brea, where numbers of trees were infested with insect pests, that were doing considerable damage.

It is necessary that all cultivators of coco-nuts should combine and have all diseased materials destroyed for it is useless for any planter to keep his estate clear of all disease while his neighbour neglects trees which become a permanent source of infection. Only the most energetic action is likely to prove beneficial, for it

All about the "Coco-nut Palm," Ferguson, Ceylon, p. lxxxiii. We have no experimental evidence of the value of this suggestion in practice, but it might be given a trial in the dry season when the weather conditions are favourable.

has been observed that there is a marked tendency for the disease to spread from centres of infection and, as mentioned previously, it appears that the disease is spreading rapidly towards the southern end of the island, probably from the Guapo district.

I am of opinion that it should be made compulsory for every cultivator of coco-nuts, no matter to however small an extent, to destroy by fire or otherwise all dead and dying trees on his grounds. The loss on some of the Cedros estates fully shows the destructive nature of the disease and therefore drastic measures must be taken or otherwise the industry must suffer considerably.

2.—ISOLATION OF DISEASED AREAS.

The disease generally appears, at first, in small patches, while the surrounding trees are apparently unaffected. As the mycelium of the fungus may spread through the soil, these diseased areas may be isolated by cutting trenches from 1 foot to 18 inches deep around them. It must be remembered that the mycelium may have spread further than is noticeable on the trees and, therefore, the trench should be made to include several trees that are apparently healthy, and care should be taken to throw the excavated soil into the diseased portion and not outside it. Such a method of isolation, especially where the diseased areas are small, cannot be too highly commended in dealing with root-diseases, but the amount of success depends entirely on the thoroughness with which the work is carried out. In any case it may prove to be a very good method of confining the disease to a limited area.

3.—RESTING OF INFECTED LAND BEFORE PLANTING SUPPLIES.

Young supplies that have been planted in infected land have shown that they have been attacked by the fungus and, therefore, it would appear necessary to rest such land for a series of years after removal of diseased material before commencing to replant. In this way it is hoped that the fungus mycelium may be starved out, and at the same time it affords an opportunity for careful cultivation of the land. Such land should be turned up, either with the plough or with the fork, so that the fungus mycelium may be turned up and exposed to the destructive action of the sun, and when supplies are put in they should not be planted in the old rows, but rather between them, so that the new plants alternate in chess-board fashion with the spots whence diseased trees have been taken.

The careful cultivation of the land before replanting should improve the condition of the soil and possibly green dressings of some leguminous plant might be profitably grown and ploughed in. Some of the soils are already rich in organic matter and here some remunerative rotation crops might be grown on badly infected lands for a year or two before planting the young supplies.

4.—SPRAYING AND APPLICATION OF CHEMICALS.

When diseased trees are cut down and destroyed there may be fungal mycelium left in the soil. As pointed out previously, a good deal of this can be destroyed by exposure to the action of the sun but it can also be destroyed, to a large extent, by the use of lime. The lime should be, if possible, unslaked, as in this state its fungicidal powers are far greater than when it is slaked. It should be applied before forking or ploughing and the amount to be used must depend upon local conditions, and upon the extent of the disease.

A method of preventing death of forest trees, etc., from root diseases in France is to lay bare the base of the trunk and as many roots as possible and to apply quantities of sulphur or ferrous sulphate. An experiment was tried with the application of a 3 per cent. solution of carbolic acid to the roots of several diseased trees at Cedros but, so far, information respecting this treatment has not yet come to hand.

The spraying of diseased trees with Bordeaux mixture may also prove beneficial in destroying spores of the fungus and applications to surrounding trees might prevent them from becoming infected by spores blown by the wind.

5.—IMPROVED CULTIVATION AND DRAINAGE.

It has been noticed that the disease is the more destructive in undrained land. Stagnant water should not be allowed to remain in the soil, as this tends to hinder healthy root development and also favours the spread of the fungus. It would appear that water may be present at the roots of the coco-nut to almost any extent, but the necessary condition is that it should not be stationary. Proper drainage not only relieves the soil of excess of water, but also allows greater root development to take place, and thus secures the plant against effects of drought.

The cultivation of land under coco-nuts is, as a rule, neglected and instances have been noticed where old plantations have been giving smaller yields of nuts that have been gradually diminishing in size, year after year. Better cultivation and drainage would offer more favourable opportunities for the coco-nut, and would probably be of considerable value in dealing with the root disease especially in wet areas with soil of a clayey nature. It would afford a better chance for the plant to make use of plant food, either from the soil or from manures (the evidence of a planter in the Cedros district, which shows returns of 120,000 nuts per year from an area that gave 40,000 nuts per year five years previously through judicious applications of manures, emphasizes the fact that the coco-nut readily responds, in some soils at least, to liberal applications of manures.) It also would be expected that the condition of the trees would be considerably improved. By encouraging healthy growth and increasing the vigour of the trees, they will be able better to withstand the attack of the fungus.

6.—SEARCHING FOR AND PROPAGATING DISEASE-RESISTANT VARIETIES.

A good deal of work has been done in combating plant diseases by selection of disease-resistant varieties, and therefore it may be a matter of the greatest importance to make further observations in this direction, as the selection of a resistant race of coco-nut may prove of the utmost importance in combating this disease. During my visits through the different parts of the island, I made careful observations and inquiries in this direction, but I am unable to say with confidence whether any varieties of coco-nut are disease-resistant. Several planters state that a variety known as the "Green-Spanish" is very hardy and is able to withstand attacks much longer than other varieties. From personal observation in the badly diseased districts it would appear as if all varieties are attacked, but if every coco-nut planter would note the comparative resistance of the various varieties, considerable advance in this direction might soon be made.

In conclusion it should be stated that in cases where the fungus has completely devastated large areas, the trees should not be allowed to stand and rot, for it would only be a nursery for the development and spread of the disease, and seeing that such varying conditions of soil and climate, etc.. exist in the coco-nut districts it is not supposed that all the remedial measures suggested will be applicable to every plantation. Therefore, it must be left to the planters themselves to choose those which they, from local experience, think to be the most applicable to their own particular conditions. The destruction of all diseased material on systematic lines, however, should be practised by all, for it is expected that by such co-operation the injury would soon be mitigated to a large extent and the disease kept well in hand.

Section 2 (a).—Leaf Disease.

23. Many trees are noticed which have leaves that appear to be drooping and with the tips of the distal leaflets of a greyish colour. An external examination of the leaflet shows that whereas the tip is quite dry and dead and that many parts of the edges of the leaflet are in a similar condition, there are small yellowish spots, more or less regular in shape, which may be observed to increase in area (spreading centrifugally from a point in a more or less circular manner), scattered about the leaflet. These areas may be observed to increase gradually in size and not infrequently to run into one another, forming irregular blotches, which often eventually cover the greater portion of the surface of the leaflet.

During the growth of the spots, they gradually change from a yellowish colour to a greyish white, and each is bordered by a margin which is of a dark colour, generally an intense greenish-brown. At first, therefore, it is easy to recognise the various "diseased spots" for in each the oldest part is always in the centre and as we proceed outwards from this, each successive ring has been more lately attacked than the last. This can be seen by the fact that the centres of the spots always become grey first while rings of yellow of varying degrees of intensity can be noticed outwards from this grey centre.

By careful observation it will be noticed that the discoloration more often appears on the under side of the leaflet first, but the pale yellow, and later the greyish discoloured areas, are equally evident on both surfaces. This is due to the disappearance of the chlorophyll or leaf green, and the subsequent death of the cells comprising the tissue of the leaflet, as the diseased areas are generally sunken through being thinner than the healthy portions.

It would appear that the tips of the distal leaflets show the effects of the disease first, although an examination of an affected leaflet shows that diseased areas are scattered all over its surface. From these distal leaflets, the disease appears to spread gradually to those nearer the stem, and often when all the leaflets on the terminal 2-3 feet of the leaf have been attacked and appear in a dry, withered condition, this portion of the leaf breaks down, if the leaf happens to be floating in the air in a position between the vertically upright and the horizontal. This end of the leaflet rarely falls to the ground, but remains hanging to the healthier postion, and is very characteristic of the disease.

If, however, the leaf is older before it is attacked *i.e.* hanging between the horizontal and the trunk of the tree, the tip does not often break. This shows that the breaking of the tip of the leaves is due to the weight of the diseased portion itself and is, therefore, due to natural causes. Many trees were examined that showed leaves with their tips broken off and hanging down in this manner and all showed that they had disease spots distributed throughout their leaflets.

The yellowish spots that are characteristic of the disease in such cases are found in the greatest abundance on the distal leaflets but eventually all the leaflets become attacked.

After a time, when a large number of disease spots have made their appearance, the whole leaf assumes a yellowish appearance and gradually becomes greyish and withered. This may remain hanging to the trunk for a considerable time but finally it drops. In the early stages of the disease, only a single leaf may be attacked, but usually several are noticed on every diseased tree. As a result of the diseased condition of the leaves, the number of nuts borne on the later-developed flower-stalks diminishes, and finally no flowers set. When a large number of the leaves have been badly attacked the terminal bud is left standing alone, and it is only a question of time before this falls over, and the death of the palm results.

Close examination on the upper surface of the leaf of one of the disease spots when it has assumed the grey colour, shows minute warts, not larger than the head of a small pin. They are blackish-grey in colour, and are irregularly distributed, often being very numerous. They are more or less oval in shape and suggest that the upper cuticle of the leaf has been raised. This can be shewn to be so, for if a diseased leaf that has fallen on the ground where sufficient moisture is present,be examined, it will be observed that these small postules rupture, usually by a triangular slit, through which a greyish powder protrudes.

24. Specimens of leaves, roots, stems, etc., were taken from diseased trees for microscopic examination and whereas the roots and stems appeared to be quite normal, the leaves were in a diseased condition. By cutting a transverse section through a diseased spot while still yellow, there could be noticed, by careful staining, a delicate, septate branched mycelium occupying the intercellular spaces and running between the cells. These eventually become pushed apart from one another by the invasion of this mycelium, from which minute branch-like structures are sent off into the cells themselves. They may possibly act as *haustoria* or sucking organs. Finally these branches appear to grow and eventually the cells and vessels of the leaf become invaded with mycelium, which probably causes the death of the invaded patches. The margin of the diseased spot is characterized by a ring of dark colour, and examination shows that here the mycelium of the fungus is only intercellular and that the filaments end in this dark margin. This shows the leaf is responding to the unnatural irritation caused by the invasion of the fungus and is probably secreting some substance with which to protect itself. Such an observation as this would suggest that the fungus mycelium is parasitic in nature and was capable of producing the death of the leaves.

When the diseased spot becomes grey and dry, the minute warts on their upper surfaces begin to make their appearance. These small pustules bear the spores of the fungus.

25. The infection experiments leave no doubt that this leaf fungus is parasitic and show that infection can take place by the germination of the spores, the germinal tubes of which can pass through the stomata of the leaf, and through wounds of any kind on the leaf surface. No result, however, was obtained when the spores were placed on the upper surface of an uninjured leaf, which therefore shows that these germinal tubes are incapable of penetrating through the epidermis of the leaf.

26. Recently, a report on a disease of coco-nuts caused by *Pestalozzia palmarum*, Cke. by Dr. Charles Bernard has come to hand from Java. Differences occur in the description of the disease from Cuba (*West Indian Bulletin* Vol. vi, p. 313) and that from Java. In Cuba, the fruiting bodies of the fungus are described as being emitted from the under surfaces of the leaves, whereas in Java the frutifications occur on the upper surface only. The distribution of the disease in Java appears to be limited to young plants and seems to do the most damage when the young plants are beginning to take root in the ground, after they have exhausted most of the stored material from the endosperm of the seed.

Despite certain differences in the appearance and size of the spores of the fungus found in Trinidad and that described from Java, the germination of the spores appears to be similar, and many symptoms of the disease in Trinidad are identical with those described in Java.

I am of the opinion that the Trinidad and Java fungi are merely geographical varieties of *Pestalozzia palmarum* Cke., and not distinct species.

27. During the short time that was given to the investigation of this disease, evidence could not be obtained on the time it takes from first infection by germination of a spore to the production of a yellow spot on the leaf nor on the time it takes for spores to be produced; but the following information on this point has been obtained during the work of Bernard on a similar disease in Java:—

> 'Two very vigorous coco-nuts situated near a diseased plantation were isolated and in the crown of one was placed a bunch of badly diseased leaves. After two months, (this is the period of time that is generally considered to be the period of 'incubation' of the disease *i.e.* the time which intervenes between the moment that infection takes place and that when the first exterior manifestations of the disease appear) this tree showed the characteristic spots upon its leaves; spots which grew and caused three months later (*i.e.* five months after infection) the death of the tree. The adjoining tree, which was not infected, remained healthy and vigorous.'

There can, therefore, be no doubt as to the cause of the disease or to the ease with which it can spread, for this parasite, as seen by the above experiment, is the primary cause of the disease and is not a secondary appearance on plants in bad condition.

It would appear, however, that the leaf, after succumbing to the numerous drains upon its resources, falls to the ground before the mycelium has attained the possible limits of its development; for if a leaf that has fallen into a dry place be placed into a moist chamber, a multitude of pustules bearing conidia will be produced within 48 hours, while, if a leaf that has fallen in a damp place, where it is shaded from the effects of the sun, be examined, large numbers of spores can be seen to be given off, thus showing that the mycelium is capable of further growth after the leaflet has fallen to the ground.

28. Evidence on the cause of the disease was gathered from planters of coco-nuts, but, as in the root diseases the general opinion was that it was due to the weakness of the plants, produced by setting immature nuts, or to improper soil conditions. It is impossible to believe that a large portion of an estate in the Mayaro district or isolated patches in the Icacos district would be planted by immature nuts alone, for the disease does not appear upon a single tree here and there. As to improper soil conditions, it is generally held that favourable conditions of soil are necessary for the growth of strong, vigorous, healthy plants, and therefore every effort should be made on the part of the planter to understand the different soil conditions of his estate and to assist nature whenever possible. This is the most perplexing question with which the planter has to contend, requiring judgment that can be gained only by many years of practical experience.

From experiments previously mentioned there can be no doubt as to the fungoid nature of the disease and measures for combating its ravages will be considered later. The spread of the disease certainly appears to be influenced by the age and condition of the plants and therefore improved cultural methods are of paramount importance.

29. The primary damage done by this fungus has been seen to be the destruction of the cells of the internal tissues of the leaflets. This destruction continues if the conditions are favourable for the fungus, and gradually the leaf-area of the plant is reduced. Under extremely favourable conditions, many of the leaves become entirely destroyed through the mycelium from a large number of disease-spots spreading throughout the whole of the interior of the leaf. When such happens, the whole of the leaf-area of the plant is destroyed, the terminal bud falls over, and the tree eventually dies.

At other times large numbers of disease-spots are scattered about the leaves but not in sufficient quantities as to cause the death of the plant. These spots, however, have been rendered, through the destruction of the chlorophyll of the leaf, useless to the plant and, therefore, the plant becomes gradually weakened.

To the planter, the most important of the checks is that given to flower development. Less flowers are produced and finally the diseased condition of the trees become marked in the shortness of the crop of nuts. Again food is cut off from the development of nuts, their size diminishes, and their saleable value becomes reduced.

It has been noticed that in some instances the shortage of crop, etc., can be traced directly back to the damage done by the leaf-fungus. In some cases where the "diseased spots" are few in number little damage was noticed, nor do they seem to increase until the conditions become unfavourable to healthy growth of the host plant.

It would appear, therefore, that this fungus is a weak parasite and is only capable of doing appreciable damage when the conditions are extremely favourable for its development.

The fungus that is present on coco-nuts in Java is also a weak parasite and there the damage seems to be limited to young plants just after being planted out, when they are sending out roots in search of food for themselves after having used up all the stored material of the endosperm of the seed. Therefore if the conditions are such as to promote healthy, vigorous growth in the coco-nuts, the fungus may be overcome and its attack, for the time at least, thrown off.

30. The distribution of this fungus appears to be fairly general, for it has been noticed to a limited extent in Cocorite, Laventille, Guapo, Mayaro (one estate) and Icacos districts, but it is probable that only in the last two is it doing any appreciable damage. In Icacos three or four acres of diseased trees were noticed and the manager of the estate reported that their death was very rapid. As a rule, within four months after the tips of

the leaves showed the yellowing, the terminal bud falls over and the tree dies. These areas were isolated from one another by considerable distances, although the first one was reported on the windward side of the estate. This district is considered to be a dry one, the soil being a good sandy loam, but it was ascertained that the diseased areas were limited to the driest portions of the estates, where the soil was of a poorer character than usual.

In Mayaro the disease was distributed throughout the interlands of one estate, and many instances of trees dying out were noticed. This portion of the estate was low-lying, damp and poorly drained. The coco-nut trees were fairly good, and it was only in the badly water-logged situations that the trees were dying in any great numbers.

It has, therefore, been observed that although the fungus that causes this disease is commonly met with in many of the coco-nut districts in Trinidad, it limits its destructive ravages to such places where the soil conditions are unfavourable to healthy plant growth. It has been shown, however, that this fungus can cause considerable damage and would certainly do so in a season unfavourable to the host plants and, therefore, it is necessary to consider what measures should be adopted to eradicate it from those portions of the estates where it is causing damage, and to prevent its further distribution.

31. A consideration of the life history of the fungus and the relation between it and the coco-nut suggest the remedial measures likely to be effective in dealing with the disease. The measures suggested can only aim at the reduction of the amount of the disease and at keeping the fungus well in check, for it would be impossible to suggest treatment that will entirely eradicate it. The remedial measures must be divided under two heads :—

(1) Those which will destroy or weaken the fungus and,

(2) Those which encourge a more vigorous growth of the coco-nut, so as to enable it to better withstand any attacks of the fungus.

(1) The spores of the fungus, under favourable conditions exist in such numbers that unless these are destroyed it is possible for the disease, given warm and moist, or windy weather, to spread very rapidly :—

(*a*) All dead trees should therefore be cut down, all the portions carefully collected on the spot where the tree once stood, and the whole *burnt*. Great care should be exercised in collecting the portions of diseased plants, and the burning should be done in the diseased-area of the field, for if diseased leaves are carried or dragged about the field there is much danger of spreading the disease. Although it is only the leaves and petioles that are diseased, it would be wise to burn as much of the tree as possible in order to prevent decaying stumps being left about the plantation to become infected with other diseases and pests.

(*b*) Trees that are showing a few diseased leaves should be climbed, the diseased leaves cut down and burned. The manager of the estate at Icacos has burned several trees that have shown signs of disease, by sending a boy up the tree, packing dry material in the lower leaf-sheath bases and setting fire to the whole. This method, in some instances, has given good results, for all the lower diseased leaves have been burned and all the fungus spores destroyed. Considerable damage, however, is often done to the tree by this method and at least two or three crops of nuts are destroyed. It would probably be just as effective to cut down the diseased leaves and burn them on the ground for in this way damage by burning would not be done to the young parts at the terminal bud.

(*c*) It would be advisable to search through the plantation to see whether any isolated trees show the characteristic broken-tips of the leaves with pustules on them, and if such are found these trees should be marked on the stem with a suitable mark so that they can be carefully watched, as they may possibly be the source of infection for another area. All leaves showing signs of disease should be destroyed with fire and such trees should be examined at least once every fortnight until no further spread of the disease is observed. These trees should be carefully attended to, manure should be given them and the soil around them properly tilled, in order to enable them to throw off the attacks of the fungus.

(*d*) If the disease continues to spread, spraying with fungicides would render the spores of the fungus incapable of germination, and would therefore be effective in keeping the disease in check. The fungus is the most easily assailed through those portions of it that come to the surface—the spores, for their germination can effectively be prevented by the use of chemicals ; but the question remaining to be solved is how frequently it is necessary to apply such an external remedy. Without further information such a problem cannot be answered, but continued observation would soon reveal an answer to this important question. How soon after complete destruction of the spores will a fresh batch be produced on the same leaf ? This is the question to be answered and such an answer must be a guide to the frequency of the use of fungicidal spraying.

Bordeaux mixture would probably be the fungicide that would be used the most economically, and spraying with this would need a spray pump and a long hose attached to the pump. The nozzle may be tied to the end of a long bamboo, or a boy may be sent with it up the tree in order that the highest tree could be sprayed. All trees showing any signs of disease and any in their immediate neighbourhood should be sprayed at frequent intervals and thus most of the spores would be prevented from germination. Appendix I has been translated from *Bulletin du Department de l' Agriculture aux Indes Nearlandaises* on the similar disease in Java and gives comparative results of different fungicidal agents, for in Java it is thought that spraying will prove to be the most effective method in preventing the spread of the fungus.

(2) It has been noticed that this disease, at present, is doing serious damage only when the conditions of the soil and cultivation are unfavourable to healthy plant growth, and therefore in order to keep the coco-nut palms in vigorous growth such points as drainage, manuring and cultivation should be carefully attended to. In the interlands of the Mayaro district, which are low-lying and often water-logged, the conditions could easily be improved by a system of drainage. The soil there is of a clayey nature and is somewhat impervious—not soil the most suitable to successful coco-nut cultivation. Some of the land is below the sea-level and, therefore, it is impossible to obtain an outflow for the surplus water but much of the surface water and that in the top six or nine inches of the soil might easily be removed by the digging of a system of wide drains about 18 inches deep. Even draining such a portion of the soil would prove beneficial to the coco-nut trees, as they feed mainly by roots in the top layers of the soil and therefore removal of an accumulated mass of 'sour' water should prove to be an incentive to further root formation.

Moreover, here, as on the estate in Icacos district, where the diseased areas appear to be on the light dry soils, the question of manuring and cultivation of the soil should be carefully attended to. Manures must not be looked upon as a means of curing disease but they may be the means of strengthening the growth of the plant and the problem of manuring should be solved by the best resources at the command of the estates.

Section 2 (b).

32. When diseased leaflets have become dry and when the wart-like pustules or *Pestalozzia* have made their appearance: there can frequently be noticed (besides the greyish-black pustules of *Pestalozzia*) small, round spots that are quite black. These black spots appear to tollow the veins of the leaflet and are usually to be seen in the greatest numbers on the upper surface of a leaflet near the mid-rib. They are also frequently seen on the lower surface of the leaflet and the flower spathes and, sometimes, the petioles are covered with black spots, the individuals of which are just visible to the unaided eye but as a whole often appear as a blackish incrustation.

On the leaflets where the black spots are seen, the greyish colour noticeable in the case of the *Pestalozzia* is marked by a dark brown colouration in the case of this second fungus. This appears to be due to dark coloured mycelium in the dried-up tissues of the leaflets. In no case has the presence of this second fungus been observed on leaflets that had not been previously attacked by *Pestalozzia*. It would, therefore, be concluded that this second fungus is only of secondary importance. Infection experiments, etc., would tend to show that it can attack leaflets that have previously been weakened by attacks of *Pestalozzia* but, until further experiments have been conducted, it is impossible to say whether it is a direct parasite or not.

33. The fungus must be referred to the *Fungi Imperfecti*, and on account of the character of the picnidia and the spores it must be referred to *Macrophoma* if the unicellular spores are considered mature and final, or to *Diplodia* if the two-celled brown spores are the final results of development.

It is possible that this fungus may be similar to that lately described by Emerson from Bowden, Jamaica, and is identical with—*Macrophoma* form with *Spaeropsis palmarum*, Cooke, from petioles and midribs of coco-nut from Demerara, and *Diplodia* form with *Diplodia epicocos*, Cooke, from dead young leaves of coco-nut.

34 This fungus has been found in Icacos, Cocorite, and the Mayaro districts and seems to be closely associated with the leaf disease and, therefore, until further experiments can be conducted to inquire into its exact habit, the remedial measures suggested for the leaf disease should be sufficient to keep it in check. Whenever it should be noticed without the *Pestalozzia* of the leaf disease, similar remedial measures should be employed and shouuld undoubtedly prove beneficial in preventing its spread.

It is hoped that before long further information can be given about the habit of this fungus and then more definite recommendations can be made

Section 3.—BUD-ROT DISEASE.

35. In having trees felled that were showing signs of the root-disease in the Cedros district, a tree was sometimes met which did not show the symptoms characteristic of the root trouble. The roots appeared to be healthy, the stem showed no signs of red discoloration, while the bud was involved in a vile smelling sort of bacterial rot. It was reported that about 1 per cent. of the diseased trees in this district showed signs of a bud trouble, but that they were seldom met with except as isolated cases. On visiting a small savannah planted in coco-nuts in the Siparia district, it was noticed that the trees were in a diseased condition. The youngest leaves appear to stand upright and do not unfold as they should. Afterwards, they turn yellow and then brown in colour and the whole appearance is that of a withering tree with the centre of the cabbage in an unhealthy condition. Sometimes this dying of the "central bud" could not be noticed until many of the lower leaves had turned yellow or brown, nor did there appear to be any regular succession of deaths of the lower leaves, for often the lowest leaves were the first to turn yellow, while at other times the "middle" leaves showed the first signs of being unhealthy.

After a time the terminal bud falls over, frequently leaving a ring of quite healthy-looking leaves at the top of a "headless" trunk.

On cutting down several of these trees it was noticed that while the roots and stem were perfectly healthy, the bases of the youngest leaves and their wrappings were in a rotten condition, as were also the bases of the still-unfolded flower stalks. This rot, in a diseased palm that is still standing, is invisible until the harder outer coverings of the bud are removed and it is found to be limited to the softer tissues. Instead of finding a healthy white cabbage, a pale-brown rotten mass is seen. It extends in badly diseased trees from the bases of the youngest leaves for a distance of three or four feet downwards until it reaches the harder tissues of the stem. Sometimes it spreads in thinnish lines, which can often be noticed externally by the leaves of one side of the tree turning yellow, while the others are apparently healthy, but at other times it seems to spread centrally, and the varying external symptoms must be accounted for by the assumption that the rot has no set method of spreading, and, therefore, whatever leaf has its food supplies cut off first must show the first signs of withering and yellowing.

A badly diseased bud is generally full of fly larvæ, etc., and the smell is awful. It resembles closely the bud of a tree badly attacked with root or leaf disease, and, therefore, suggests that further researches are greatly needed before any definite conclusion about its origin can be arrived at.

36. Microscopic examination of the roots and stem indicated that they were quite normal, while those portions of the terminal bud, in the advancing margin of the disease showed in most cases bacteria of different kinds, only in two instances was the advancing margin marked by a reddish discolouration produced by some fungal mycelium. Although this mycelium has been more or less successfully isolated, the fruiting bodies have not been obtained nor have the few infection experiments given positive results. Of the bacteria, two have been isolated in pure cultures, while at least one more has been observed in a rotten bud. Two of the bacteria are apparently gas-producers and have been found in rotten terminal buds of trees that have suffered from the leaf-disease or the root trouble, while another has only been noticed in rotten buds from the Siparia district.

37. Whenever the youngest visible leaf is observed to be lopped over and wilting, the terminal bud is sure to be involved in a soft rot. The roots and stem appear to be quite healthy and no evidence of damage to the tree could be found.

The few isolated cases in the Cedros district would indicate that this disease is not of a very infectious character, but large numbers have been killed out in the Siparia district, the spread being very rapid and apparently from the windward. I am inclined to the view that this disease is similar to the destructive disease of coco-nuts in Cuba, but, as far as Trinadad plantations are at present concerned, it would appear to be largely due to unfavourable conditions of soil, drainage, etc.

Weakly trees whether caused by bad drainage, inferior cultivation or inferior soil, are the most likely to be those that are attacked by disease and therefore improved conditions of cultivation, etc. should render the trees more capable of withstanding attacks.

38. More prolonged study and much experimental work is necessary to demonstrate conclusively the cause of the disease. With our present knowledge of the nature of the disease it is impossible to suggest a remedy for trees that are already infected,* and, therefore, steps must be taken for preventing its spread.

The rapidity with which the trees have been killed in the Siparia district and the marked resemblance of this disease to that which has proved such a menace to the coco-nut industry of Cuba, should illustrate the need for vigorous action being taken in order to prevent further spread of this disease.

All diseased trees showing only the 'bud-rot' should be cut down and destroyed. If the planter is sure that it is only bud-rot and not root disease (which is characterised by the disorganized condition of the cortex of the roots and by the reddish ring of discoloration in the stem) it should be sufficient to cut off the top 4 or 5 feet from the diseased trees and bury deeply with lime (it would be found impossible to burn such rotten masses as diseased buds). The remainder of the trunk and all rubbish should also be collected and burned or otherwise it may serve to harbour other pests, which eventually may become destructive. Felling and destroying diseased trees is undoubtedly an expensive process but the neglect of these precautions may make all the difference between a trifling loss of trees and a serious epidemic.

It is also necessary that united action should be taken, for it is useless for one planter to care for his estate and destroy all diseased material while his neighbours allow the disease to multiply and their estates to become centres of infection.

From observations made in the Siparia district, it would appear that any variety of coco-nut tree may be attacked, but it would be advisable to look diligently for plants that are resistent to this disease for the selection of the most hardy varieties may be a means of assisting better cultivation, destruction of all diseased material, etc., in dealing with this disease.

Section 4—SUMMARY AND CONCLUSION.

38 a. In conclusion, it has been possible to establish three separate diseases of coco-nuts in Trinidad, besides those caused by the presence of insect pests. These latter are, at present, doing comparatively little damage, except on one estate in Mayaro district that is suffering from attacks of scale, on another neglected estate in La Brea that was infested with beetles, and another small area in the Icacos district suffering from locusts.

39. The three diseases have been called the "Root-disease, the "Leaf-disease" and the "Bud-rot."

*In Jamaica spraying with Bordeaux mixture has been proved to be a remedy. *Editor, Bulletin of the Department of Agriculture, Jamaica.*

40. The Root-disease is, without doubt, the most serious; it is widely distributed, and is causing considerable loss in the Guapo and Cedros districts and in some of the heavy undrained interlands at Mayaro, as well as in smaller areas at Laventille and Cocorite, while it has been reported from Toco and Guayaguayare.

41. It is apparently caused by a fungus, a species of *Botryodiplodia*, and may be recognised by the yellowing and hanging down of the leaves, by the disorganised condition of the cortex of the roots, by the red ring of discolouration that may be seen in the stem, and by the pustules bearing fungus spores that are invariably seen, sooner or later, on the dead petioles.

42. There are reasons for concluding that the disease is primarily one of the roots, and, although the mycelium of the fungus present in the roots is not continuous through the stem with that in the petioles, experiments tend to indicate that they are of a similar nature, and, therefore, the petiole trouble, though secondary in destruction may be one of the primary means of distribution of the disease.

43. The disease may spread through the soil by means of mycelium, by spores blown by the wind from tree to tree, and by means of the fall of diseased petioles, while replanting of supplies on diseased spots without proper cultivation and treatment may be a means of continuing the disease in the next crop of trees.

44. The disease appears in all soils, but apparently spreads the more rapidly and is the more destructive in damp, low-lying, undrained hollows. Careful attention to drainage, cultivation and application of manures should increase the vigour of the trees and render them less susceptible to attacks of disease. Undrained, uncultivated, neglected portions of any estate are a standing menace to the whole estate and perhaps the whole district.

45. To prevent further spread of the disease, the following remedial measures has been suggested :—

(*a*) All dead or dying trees, diseased leaves and petioles that have fallen to the ground, rubbish, etc should be destroyed, either by fire or by burying deeply with lime.

All stumps should be grubbed up and as many diseased roots as possible destroyed.

(*b*.) When small areas are noticed, they may be isolated from the remainder of the estate by digging a good trench around them. This should prevent spread of mycelium in the soil to other portions of the estate.

(*c*.) Resting and cultivation of infected land that has been cleared and burnt before replanting ' supplies.'

(*d*.) Spraying and application of chemicals to destroy spores and also mycelium in the soil.

(*e*.) Replanting should be done with ripe nuts from disease-resistant trees if such can be found.

46. The leaf disease is limited to small areas, which are apparently in want of better cultivation, and seeing that a similar disease has caused considerable damage to coco-nuts, especially

to young plants, in Java, it is worthy of consideration and should be carefully looked for.

47. It is caused by a fungus—a species of *Pestalozzia* and may be recognised by the yellowish spots on the leaflets especially near their tips. These spots gradually increase in size, the distal leaflets of the leaf turn yellow, then brown, and eventually die. When the leaflets for the terminal 2 or 3 feet of the leaf have died, this portion breaks off and hangs vertically downwards from the end of a dying leaf. This is characteristic of the disease and is probably due to the weight of the dead tip causing it to break off. The spots on the leaves become a greyish colour and bear on their upper surfaces the spores of the fungus,

48. These spores are capable of distribution by wind or rain and are capable of infecting another leaf directly, provided that sufficient moisture and air be present. They send small tubes into the tissues of the leaves, which destroy them and eventually cause the death of small spots. By an attack of a large number of spots the leaflet is wholly killed out.

49. This fungus—*Pestalozzia* sp. is frequently but not always accompanied by another fungus—*Diplodia epicocos*, the fructifications of which may be observed as small black spots generally along the veins of the leaflets near the midrib or on the petioles, but experiments so far indicate that it is either saprophytic or only completes destruction commenced by *Pestalozzia*. More work however is necessary in this direction in order to fully establish the connexion between the action of these lwo fungi, if there be any.

50. Spread of this disease is accomplished by means of wind and rain and, therefore, besides making every effort to keep the coco-nut trees healthy and vigorous by improved cultural methods all sources of infection should be removed as they may be the cause of considerable damage during an unfavourable season.

The following remedial measures are recommended :—

(*a*.) All dead trees should be cut down and, with diseased leaves, &c., should be destroyed, preferably by fire.

(*b*.) Isolated trees, that show signs of disease, should be marked, carefully watched and all leaves that become attacked, cut out and burned.

(*c*.) All plants in the diseased area should, as a preventive, be sprayed repeatedly with Bordeaux mixture, particular attention being given to the more delicate leaves.

51. A bud-rot disease was noticed in isolated cases in the Cedros district and had apparently caused the death of many palms on the Savannah in the Siparia district.

52. The cause of the trouble is somewhat obscure. The roots and stem of the palms appear to be quite healthy while the bud is involved in a vile soft rot. In one instance a fungus was present in the advancing margin of the disease but generally bacteria were the only organisms present. Three kinds of bacteria were noticed and two of them had previously been found in trees that were suffering from other causes. On no occasion

could it be established, with certainty, how the bacteria gain an entrance or whether they are the primary cause of the trouble.

53. In theSiparia district the spread of the disease was very rapid but it is probable that more careful attention to cultivation, etc., and prompt destruction of all diseased material would tend to keep this disease well in hand.

54. Finally it must be urged that in dealing with the diseases of coco-nuts, the adoption of remedial measures must be carried out systematically by all interested in coco-nut cultivation, wherever the disease is present, in order that a check can be put upon its spread, and I am of opinion that every planter of coco-nuts should be made to carry out such remedial measures that will suit his local conditions—at any rate he should be made to destroy all dead trees on his grounds for, by co-operation of the planters in this matter, it would be possible to check the diseases and probably to eradicate them.

I have the honour to be,

Sir,

Your most obedient Servant,

F. A. STOCKDALE,

Mycologist.

SIR DANIEL MORRIS, K.C.M.G.,
Imperial Commissioner of Agriculture
for the West Indies.

PRUNING COCOA.

By W. CRADWICK, Travelling Instructor.

Young Cocoa plants require no pruning until they commence to "fork" or form a "crown;" from this stage they require the most careful watching, and the pruning should always be done on "the little and often" system. As soon as the little branches peep out from the "crown," they should be reduced to 3; that is, if there are 4 little branches, cut out one; if there are 5 cut out 2. If this is done before they are 2 inches in length it does not make the slightest difference which two are destroyed; although a careful pruner would always have his eyes open to select the two most feeble; destroy these and leave the three strongest to grow. This is the most important pruning operation in the whole life of the tree, and if done at this very early stage, the tree will always grow well balanced. The young tree will from this time onward require little pruning, except to remove suckers or gormandizers, until the three branches commence to grow side branches; as soon as they do this, care and forethought must be exercised in the highest degree in pruning the young trees.

How far from the centre of the tree should the primary branches be allowed to grow, before they are allowed to send out side branches is a question asked me over and over again. No rule can be laid down; a powerful, strong growing tree, in rich soil, well sheltered situation, can have the secondary branches removed to a distance of 3 feet from the crown, other trees will be pruned quite sufficiently if these are removed to a distance of a foot or

18inches. Hard and fast rules cannot be laid down for living things: being living things, they have a voice in these matters themselves, and unless this voice is respected, dire will be the results to the owner of the tree. Some trees have a tendency to grow long and weak in the branch, others are inclined to grow stiff and upright, characteristics such as these, must be watched for, and the trees pruned accordingly.

When the secondary branches commence to grow, it will be noted that some of the young shoots are strong and vigorous, perhaps one out of every three or four, while the intermediate ones are smaller, some being quite puny. In pruning for secondary branches, careful selection should be made to leave these strong growing secondaries, removing the weaker ones, thus the first strong secondary at from a foot to 3 feet, according to the strength of the tree, from the centre, would be selected as the base of operations in pruning for secondaries.

An ideal cocoa tree is one with a main stem of 3 to 4 feet in height, three primary branches with the first secondary growing from 18 inches to 2 feet 6 inches from the crown of the tree, the next secondary growing on the opposite side of the primary about 1 foot further from the crown than the first secondary; the third secondary on the same side of the primary as the first, about 9 inches further up the primary than the second secondary. The secondaries alternating up the primary, gradually becoming closer together as they get further from the crown, until the whole tree forms an umbrella of branches, say, 10 feet in diameter. I very much doubt if trees occupying more space than this, are profitable. These are the ideal trees, and while a high percentage of ideal trees can be looked for with proper treatment, it is not to be supposed that all trees will be ideal.

How high should I allow my Cocoa trees to grow, before I make them branch is another stock question. I have mentioned the height at which I *like* them to branch, but there is no *making* a tree branch, except as this is effected by general treatment, soil, light, &c. The better the seed, the stronger the young plant, the richer the soil, the more dense the shade, in reason the higher will the young plant grow before it commences to branch.

It must always be remembered that naturally a young cocoa tree grows in a moist, rich, heavily shaded position; and these circumstances must be copied as nearly as possible if a good cocoa tree is desired. As the tree grows it can stand more light, more wind, and eventually will grow in positions exposed to full sun and heavy breezes.

I have seen young cocoa trees where they were heavily manured from yard sweepings, heavily shaded by breadfruit trees, growing to a height of 15 feet, before they formed a crown; in other cases they have branched at little more than a foot from the ground, this being the result of poor soil, a feeble plant, or over exposure. Such plants should be allowed to send up a sucker as soon as they have vigour enough to do so; such suckers being encouraged to form permanent trees, and the first set of primaries destroyed as soon as the sucker is big enough to warrant this operation.

In some cases, although not often, it will be necessary to allow a second sucker, in order to get the necessary height of the crown above the ground. Trees which branch too low never seem to be quite as vigorous as those which branch as near to the ideal height as possible. It is difficult to keep the air circulating through trees which have branched too low, and it is much more inconvenient to work among such trees. The greatest care is necessary in the carrying out of the details on pruning. It is appalling to see pruning in many places. Provide a good sharp knife, it cannot be too sharp; then if the pruner does not make a good clean cut close into the old branch, so that there is no snag sticking out to rot and decay the parent branch, it is time to talk to him, but do not expect a man to do scientific pruning with a piece of iron hoop from Germany or Birmingham, shaped up to look like a knife.

The removal of big branches, which should only be necessary in cases of accident to big trees, should be done with a very sharp saw, or cutlass, the wounds always being pared smooth with a good sharp knife, and smeared over with a composition consisting of half Stockholm tar and half grease, melted together and applied warm. Small cuts made, in removing branches of, say an inch in diameter, should be treated with paint instead of tar, or still better with knotting varnish; the latter is much to be preferred for all kinds of wounds, the only objection being the expense.

In the case of old cocoa trees being damaged, allow them to send up a young sucker, and treat this in the same way as recommended for pruning young plants, allowing the old tree to go on bearing, until such time as the young sucker has formed a new tree. It is wonderful how soon they will do this on good land. Fifteen months after the hurricane of 1903 I saw suckers at Spring Valley in Hanover, which had grown to the height of 10 feet and were actually bearing, while the old portion of the tree, practically lying on the ground, was also bearing. Old trees which have decaying wood in them as a result of accident or bad pruning, should have this carefully removed, being careful to cut right back into the healthy portions of the tree, and then paint the wounds over as previously recommended. Care should be taken to remove all prunings from Cocoa walks, and burn them, as these are fruitful sources for the propagation of disease.

A BOTANICAL EXPEDITION TO JAMAICA.*†

By DUNCAN S. JOHNSON, Ph. D., Professor of Biology, Johns Hopkins University, Baltimore.

The writer, accompanied by Messrs. W. D. Hoyt and I. F. Lewis,

* From The Johns Hopkins University Circular, No. 3, pp. 21–25.
† The expedition was aided by a grant from the Bache Fund.

spent two months of the spring of 1906 engaged in botanical study in the island of Jamaica. Most of the time was spent at Cinchona, the Tropical Station of the New York Botanical Garden. Here we joined Dr. Forrest Shreve, who was spending the year of his tenure of the Bruce Fellowship of this University in a study of the forest of the Blue Mountains of Jamaica.

While on the island, the writer was engaged in studying and collecting developmental material of the native species of Piperaceae and Chloranthaceae. A former visit in 1903 showed Jamaica to be a very favourable place for the study of these groups of plants. Some of the species obtained in 1903, which proved most interesting, were forms of which but little material was found, or of which, because of the shortness of the stay, but few developmental stages were secured.

During this second trip more complete material of the species found in 1903 was obtained and a considerable number of new forms were collected. Altogether material is now at hand for the study of the seed development of twenty Jamaican species of Peperomia and twelve species of Piper.

A considerable number of species of Peperomia occur in the lowlands of Jamaica, but they are more abundant in the highlands, especially in the Blue Mountains. Here they occupy a great variety of habitats, and show modifications in structure which are often clearly adaptive to the peculiarities of the habitat.

Along the trails at from 1,200 to 1,800 meters elevation, on the dryer southside of the Blue Mountains, several strongly xerophytic species of Peperomia occur. Among these are *P. reflexa*, *P. quadrifolia*, and *P. verticillata*. Higher up on exposed limestone cliffs *P. galioides* is found. In the wooded areas, between the altitudes mentioned above, several slightly less xerophytic species occur on the soil of ridges or hillsides, on shaded rocks, or as epiphytes. Among these are *P. acuminata*, *P. distachya*, *P. glabella*, *P. maculosa*, *P. magnoliaefolia*, *P. rhombea*, *P. stellata*, and *P. septemnervis*.

In the dense forests *P. tenella* and *P. filiformis* occur as epiphytes, while the very delicate *P. hispidula* is found among mosses on the saturated humus of the forest floor in deep ravines.

The extremes of adaptive structure that may occur in this single genus can best be indicated by comparing a xerophytic species such as verticillata with a hydrophytic one such as hispidula. *P. verticillata* is a hairy species 15–25 centimeters high, with an erect, fleshy stem. The obovate leaves are 15–20 millimeters long, 10 millimeters wide, and many of them are swollen to a nearly hemispherical form with a massive water storage tissue. The leaves as well as the stem are covered by a dense layer of thick-walled, several-celled hairs, which seem capable of aiding the thick cuticle in reducing transpiration to a minimum.

Not only in the structure of the vegetative parts, but also in that of the inflorescence, this plant is strikingly fitted for a dry habitat. The axis of the spike is fleshy and the ovaries and stamens, when young and delicate, are sunk in depressions of the axis and protected without by the circular tops of the long-stalked, overlapping bracts. Later the stamens and the blunt, stigmatic tip of the sessile ovary are protruded between the bracts to allow pollination, but the fruit, even when ripe, remains half imbedded in the axis.

In *Peperomia hispidula*, on the contrary, we have a delicate form only five or six centimeters long, with slender translucent stem and roundish, thin leaves. The latter have delicate veins, the lamina toward the edge consists of but two or three cells in thickness and the outer cell walls are covered by only a very thin cuticle. Over the upper surface of the leaf are scattered delicate hairs, which are not easily wetted, and serve perhaps to keep the leaf surface free from water during rainy periods.

The structure of the inflorescence is also strikingly different from that of *P. verticillata*. The axis of the spike is slender and delicate, and the bracts are small and short-stalked. The flowers are finally widely separated by the elongation of the internodes of the axis, and the fruits while still young stand out from the axis, each on a distinct stalk or peduncle of considerable length.

Between the extreme types of adaptation shown by the two species just described, all intermediate conditions are found. In the study now being made of the genus the writer is attempting, first—to discover more exactly the relation of the structure observed in the vegetable organs to the external conditions affecting each species; second—to learn whether the different types of seed development, found in various species of Peperomia, are correlated with peculiarities of vegetative structure and thus perhaps with environmental factors.

The species of Piper and of Hedyosmum found are being studied primarily for the purpose of discovering whether the seed development of any species may suggest the origin of the peculiar embryo-sacs found in all the species of Peperoma hitherto studied. The results thus far obtained serve to emphasize the isolation of the genus Peperomia, at least as regards the mode of development of its embryo-sac.

Mr. W. D. Hoyt was at Cinchona from April 21 to July 7 engaged in studying and collecting the prothallia of the native ferns. Interesting facts as to the structure and habitat of the prothallia of certain species were obtained, and the spores of many more species were also collected. Prothallia are now being grown from these spores, which are to be used in an experimental study of the problem of hybridization in ferns.

Mr. I. F. Lewis spent the time while in Jamaica in making a study of the fresh water algae of the Blue Mountain region.

The most complete list of Jamaica algae, that of Collins* includes 32 species of fresh water algae. The majority of these were collected by Prof. J. E. Humphrey of this University, from the foothills of the Blue Mountains. In the list are 14 genera and 29 species of Cyanophyceae and 3 genera and 3 species of Chlorophyceae.

* Collins, F.S.: The Algae of Jamaica: Proc. Am. Acad. XXXVII, 1901, pp. 231-270.

The paucity of Chlorophyceae at lower elevations is striking. Collections made by Mr. Lewis in June and July of 1906 show, however, that the green algae are rather well represented in the moist regions at higher elevations. Eighteen genera were found in the Blue Mountains. Of these, 15 are new to the local flora.

Cyanophyceae are more common at all elevations than Chlorophyceae. Of 12 genera collected only 5 are not recorded in Collins' list.

Rhodophyceae were found to be represented in the algal flora of the mountains by *Hildenbrandtia rivularis*, which occurs on stones in the rapidly running streams of high altitudes.

Material fixed and preserved for a morphological study of the three species of Trentepohlia. One of these was found to be particularly subject to attacks by parasitic fungi. Three species of fungi growing on the Trentepohlia appear to form simple lichens. Material was preserved for further study of the incipient lichens.

TWO NEW SPECIES OF COMOCLADIA COLLECTED IN JAMAICA.*

By DR. N. L. BRITTON, Director-in-Chief, New York Botanical Gardens.

Comocladia cordata (sp. nov.) A tree, about 15 m. high, glabrous throughout. Leaves about 2 dm. long; leaflets about 13, ovate to oblong-lanceolate, firm in texture, dull green, slightly paler beneath than above, strictly sessile, entire-margined, cordate at the base, acute or short-acuminate at the apex, 5–9 cm. long, 2.5–4 cm. wide, the veins diverging from the midvein at nearly right angles and curving upward; lower leaflets smaller than the upper ones, the pairs distant; panicles as long as the leaves or shorter, about 8 cm. broad, their branches very slender; flowers numerous, purple, 1.5 mm. wide; pedicels filiform, 1–3 mm. long.

Rocky wooded hill, Troy (Britton *640*), [Harris *9416*]. Nearest to *C. integrifolia*, Jacq.

Comocladia velutina (sp. nov.) A tree, 6 or 7 m. high, the young twigs, foliage and panicles densely brown-velutinous. Leaves about 2 dm. long; leaflets about 13, oblong, rather firm in texture, paler beneath than above, blunt and rounded at the apex, truncate or subcordate at the base, slightly repand on the margin, 2–7 cm. long, 4 cm. wide or less, very shortly petioluled, the lower pairs much smaller than the upper; petiolules 2 mm. long; panicles as long as the leaves or shorter, the branches slender; flowers dull crimson; fruits oblong, very shortly stalked, 1 cm. long, 6 or 7 mm. in diameter.

Great Goat Island (Harris *9208*). Perhaps nearest related to *C. pubescens*, Engler.

* From "Torreya", Vol. 7, No. 1, Jan. 1907.

BOARD OF AGRICULTURE.

EXTRACTS FROM PROCEEDINGS.

The usual monthly Meeting of the Board of Agriculture was held at Headquarter House on Wednesday 12th June; present: Hon. H. Clarence Bourne, Chairman; the Island Chemist; the Acting Director of Public Gardens; His Grace the Archbishop; the Superintending Inspector of Schools; Messrs. G. D. Murray, Conrad Watson, and the Secretary.

Arrowroot—The Secretary submitted correspondence with the Superintending Medical Officer on the question of supplying the public institutions with Jamaica Arrowroot instead of importing from St. Vincent. A list of the prices paid by different public institutions, including country hospitals, show that local contractors charge prices ranging from 3d. to 6d. per lb. The supplies for the General Penitentiary are imported from St. Vincent. The Kingston Public Hospital appear to get their supplies from the Penitentiary, no supplies being kept at the Island Medical Stores. Previous correspondence had left the impression that the Island Medical Stores were responsible for the supplies used in public institutions generally, and that the arrowroot used was imported. The Secretary was directed to continue his efforts to secure local supplies for the public institutions, if available.

Vanilla—The Secretary reported that, as instructed, he had written to the Rev. John Maxwell, Giddy Hall, St. Elizabeth, who had long taken much interest in Vanilla cultivation and grown it to a small extent, and that gentleman had replied giving full information as to his method of curing, and saying he would be pleased to devote some time to visiting districts in Westmoreland and Hanover to explain to the small growers there how the crop of pods, now ripening, should be handled, if his travelling expenses were paid. He further stated that Vanilla growing and curing was an industry that thousands of girls in certain districts not fit for field work and unable to earn a living by needlework, could engage in easily. The Secretary stated that he had already circulated the papers, and he read the remarks of members. After further discussion, it was agreed that although Vanilla growing was a declining industry in the Seychelle Islands, owing to the competition of the artificial product Vanillin, and to disease, the vines grew so readily in certain districts of Jamaica, and the pods cost so little to produce, that it would form a suitable additional industry for small settlers. It was, therefore, resolved to accept Mr. Maxwell's offer to assist the industry, and, subject to the consent of the Governor, pay his travelling expenses from the vote for travelling of the Director of Public Gardens and Plantations, the whole of this vote not being required by the Director this year.

Brahmin Bulls—The Secretary reported that with regard to the order for two Brahmin Bulls for Texas, U.S.A., he had a letter from the Agent of the Leyland Line, New Orleans, stating that

Brahmin Bulls bred in Jamaica could not be landed at New Orleans.

Hindoo Artisans from Peru—The Secretary submitted a letter from the Colonial Secretary's Office forwarding copy of correspondence with regard to a telegram from the British Minister at Lima, Peru—"Many Hindu labourers and artisans leaving for Kingston...can they obtain work on arrival?" The Protector of Immigrants wrote that on account of the drought, planters had no difficulty at present in getting all the labour they wanted, which was proved by the fact that notwithstanding the recent reduction of the Indenture fee for East Indian Immigrants to £17 10s. per unit, applications for only 589 Immigrants were received; that employers would not be likely to agree to indenture East Indian labourers who had not been recruited and medically certified as fit for labour in accordance with the prescribed Government procedure.

Certain members of the Board expressed the opinion that Hindus from Peru might not be a desirable class of persons to mix with our people here.

There were no reports from the Chemist.

The following reports from the Director of Public Gardens were submitted:

1. Hope Experiment Station.
2. Instructors.
3. Letters from Mr. P. W. Murray, Instructor of School gardens.

   Mr. Cradwick, re School Gardens.

Nos. 1 and 2 were directed to be circulated; the latter were read and tabled.

The following papers which had been circulated were now submitted for final consideration:

(a) Appropriation Accounts, Government Laboratory, 1906-7
(b) Finance Accounts, Board of Agriculture Deposits, 1906-7
(c) Report, Hope Experiment Station.
(d) Mr. Briscoe's Report and Itinerary.
(e) Mr. Crawick's Itinerary.
(f) Report by Mr. Cradwick on Cocoa trees in St. Mary.
(g) Re Vanilla.

A discussion ensued on the attacks of Fiddler grubs on Cocoa trees and the best method of dealing with the pest.

The Chemist stated that he had imported a fresh supply of Bisulphide of Carbon for the use of planters at cost price, if they applied for it.

The usual monthly meeting of the Board of Agriculture was held at Headquarter House on 17th July: present—Hon. H. Clarence Bourne, Colonial Secretary, the Acting Director of Public Gardens, His Grace the Archbishop, the Island Chemist, the Superintending Inspector of Schools, Messrs. C. E. DeMercado, G. D. Murray, Conrad Watson, and John Barclay, Secretary.

Arrowroot—The Secretary reported that he had written to the managers of all the hospitals in the island asking whether they used native or imported arrowroot and the price paid. He had twelve replies from which he found that they all bought their arrowroot locally ; eight got imported arrowroot, three native, and one D.M.O. replied that he made no special enquiry whether the arrowroot was native or imported. The lowest price paid was 3d. per lb. but that was only in one instance. There was one at $3\frac{1}{4}$d. one at $3\frac{3}{4}$d., five at 4d., three at 5d., and three at 6d. Some of the Kingston Institutions also bought imported arrowroot locally at 5d. per lb. No arrowroot was sent out from the Island Medical Stores. The Secretary read letter from Rev. Mr. Gartshore, Secretary of the Agricultural Society in Hanover, who said he was very anxious to get the settlers there to grow enough to supply native institutions. The Secretary said that the difficulty was to get a start and to arrange that the wants of the institutions should coincide with the supplies when ready. The Island Chemist stated that one D.M.O. had forwarded a sample of the arrowroot used at a local hospital, and his analysis proved that it was corn starch, or arrowroot highly adulterated with corn starch, which was a cheaper commodity than arrowroot.

The Secretary was instructed to arrange to meet the Superintending Medical Officer and confer with him to see what arrangements might be arrived at, so that Public Institutions might be supplied with native arrowroot if possible.

Vanilla—The Rev. John Maxwell wrote that Vanilla pods would be ready for curing about October, and he would arrange to give the necessary instruction to the settlers growing Vanilla in St. Elizabeth, Hanover and Westmoreland during that month. The Secretary will ask Mr. Mennell, Instructor for Hanover, to associate himself with Mr. Maxwell. He will submit Mr. Maxwell's proposed arrangements at the next meeting.

Importation of Brahmin Bulls to U.S.A.—The Secretary read letter from the Bureau of Animal Industry advising that such animals as Brahmin Bulls can only enter the United States at New York, Boston and Baltimore, and only if accompanied by a clean Bill of Health from the Veterinary Surgeon here, and would be subject to rigorous inspection and quarantine at the port of entry.

The Secretary submitted the following letters from the Secretary of the Agricultural Society, as follows :—

Cotton Industry—1. Informing the Board that he had imported 1,500 lbs. of selected Sea Island Cotton Seed which was being disinfected at Hope Gardens and would be available for sale and for free issue in small quantities for experiments ; that in addition to one fairly large cultivation in St. Andrew, a good many cultivations from one to five acres were in prospect. In order that as few mistakes as possible should be made in the preparing of the land and planting, he asked that the Agricultural Instructor, Mr. Briscoe, be allowed to devote a good part of the next month to giving instruction and advice in this industry in St. Andrew.

As it would be important to know whether St. Vincent or native seed gave best results, he had arranged with various cultivators to plant both separately, but owing to the difficulty of getting accurate statistics, it would be useful if they could plant a square chain of each kind at Hope Gardens and follow the growth of the seed through to the final results. The Acting Director was willing to carry out the proposed experiment. This experiment was then authorised. Mr. Watson said that it had been proved that there were great differences in the growth of seed, even from the same plantation. That kind of seed with the tuft of cotton remaining on the end was superior in results to the clean black seed, and it might be as well to have a special experiment in this direction also.

Instructors—2. Intimating that the Board of Management of the Agricultural Society had adopted a report of the Instructors' Committee, who had before them recommendations from the Acting Director of Public Gardens, letters from Mr. Cradwick containing suggestions, and information from the Secretary, all as representing the Board of Agriculture—and which recommended a new Instructor's district to be formed consisting of St. Catherine and Clarendon, thus relieving Mr. Cradwick of St. Catherine, Mr. Arnett of upper Clarendon, and Mr. Palache of Lower Clarendon ; and that Mr. J. Hirst, who was resident at Mocho in Clarendon, and who was formerly one of the local instructors in the employment of the Society, be appointed for the new district at a salary of £200 a year for eleven days actual travelling work per month ; that he would arrange with Mr. Cradwick and Mr. Briscoe to define their boundaries in those localities which overlapped ; that he would arrange with the Instructors to meet each other in those districts so that they might confer jointly on the system of the work to be followed, so that there might be more continuity and homogeneity in the work than now exists.

These arrangements were agreed to as regards Instructors, and sanction was given that Mr. Briscoe, arrange an itinerary for visiting cotton growers in St. Andrew on condition that such arrangements could be made without withdrawing from any arrangement or promise previously made with other districts.

Drought in St. Elizabeth—The Archbishop asked leave to bring up a matter that he was interested in. He said he thought it was an opportune time to bring forward the matter of impressing the value of Cassava Farine as a food, more especially with relation to the people in St. Elizabeth. Surely something could be done to prevent anything like a famine occurring in that district. After the last attack by drought ten years ago the Agricultural Society did something in this direction.

For the information of the Chairman and Mr. Watson who were not in the Island then, the Secretary explained what had been done by the Agricultural Society and the cause of their efforts falling through, not only in regard to Cassava Farine, but also encouragement in growing a drought-proof money-yielding crop, the grape vine, which flourished with little attention on those same plains, and bore best in the driest weather. After discussion, Mr. Watson said that in some of the other West Indian Islands that he was familiar with, the people baked cassava bread hard and stored it—it would keep for twelve months. It was a usual custom, and although they had not the advantages of the settlers in Jamaica by any means, they were not subject to famine. This bread could be used at any time someting after the manner of ship's biscuit. Some members thought that as cassava could be kept in the ground through dry weather, almost as well as farine could be kept, it was largely a matter of improvidence ; although the people stored farine or cassava bread, probably they would not be able to keep it long enough.

As the Governor had arranged to visit St. Elizabeth, nothing definite was done in this connexion meantime.

The following reports from the Director of Public Gardens were submitted :—

1. Instructors.
2. Hope Experiment Station.
3. Special reports from Mr. Cradwick as follows :—

Cocoa—1. Asking leave of the Board to visit Mr. Roberts' cocoa at Bog Walk, and Mr. Calder's at Worthy Park to enquire into the supposed immunity of the red podded Forastero Cocoa from fungus pests, which often ruined the crop of the yellow podded trees ; also that the taking of the cocoa seeds or plants from the eastern end of the Island, that is, anywhere east of Porus, to the western end of the Island might be prohibited, as there was no trouble from fungus pests in the west end, and it would be a thousand pities to introduce any disease in the Criollo plantations which the people were establishing there.

The authority asked for to visit cocoa plantations in St. Catherine was given, providing it did not interfere with any made-up itinerary.

The Acting Director of Public Gardens stated that it would not be possible for the gardens to stop issuing plants to anyone who wished them in the western part of the Island ; and at any rate there was no sign of disease in any plants issued from the gardens.

2. Stating that it had been brought to his attention that the smoking of Gunjah was much on the increase on the northside of Jamaica, not only among the coolies but also to a very large extent among the creole labouring class, and whether the Government could be asked to take any steps to prevent the spread of this evil.

After discussion on the subject, in which the Chairman stated his experince in Trinidad, it was decided that it would not be advisable to recommend any legislation on the subject.

Tobacco—The Acting Director of Public Gardens reported that a tobacco merchant who had a business in Havana and New York City was now in Jamaica, stated that a great deal of the tobacco which he had seen here was quite suitable for wrappers, and he was prepared to buy all that he could get. The Acting Director stated that the tobacco from last year's experiments at Hope which had been offered in vain to local merchants and also the present season's crop had been bought by this merchant. The merchant was anxious to establish business here, would be always ready to pay the highest rates for tobacco, and saw no reason why wrappers should be imported for local use as a large proportion of the best leaves could be used for wrappers. He also strongly advised the use of stable litter as a fertiliser for tobacco lands. The litter should be spread over the ground and ploughed in. He further stated that it had been proved that tobacco grown in land so prepared, produced larger leaves, which when properly cured, were of a particularly fine silky nature—that commercial fertilisers had proved a failure in tobacco growing in Connecticut.

Mr. deMercado stated that he had met this gentleman and given him such information and instruction as he thought would further the tobacco interests of the Island.

The following reports from the Chemist were submitted :—

1. Application for Distillers Course 1907.
2. Leave of absence of lecturer in agriculture.
3. Removal of Carbon Bisulphide and Thymol Services.

Nos. 2 and 3 were directed to be circulated, and No. 1 to be forward to the Advisory Sugar Committee.

The following papers which had been circulated but had not yet been before the Board were submitted :—

1. Report from Mr. Briscoe for St. Andrew and St. Thomas.
2. Chairman's annual report.

The Secretary was instructed to forward the latter to the Governor.

[Issued 16th August, 1907.]

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BULLETIN

OF THE

DEPARTMENT OF AGRICULTURE.

Vol. V. AUGUST & SEPTEMBER, 1907. Parts 8 & 9.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.,

Director of Public Gardens and Plantations.

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BULLETIN

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Vol. V. AUGUST & SEPTEMBER, 1907. Parts 8 & 9.

THE CULTIVATION OF COCOA IN CEYLON, II.*

By HERBERT WRIGHT**

GENERAL CHARACTERISTICS OF VARIETIES.

We shall first briefly outline the general characters of the numerous varieties of cocoa grown in Ceylon and other countries and see what features can be relied upon as indicating the value of the different forms of cocoa. It has been shown, when dealing with the history of cocoa in Ceylon, that most of our seed supplies have been obtained from Trinidad, and the systems of classification drawn up by Morris and Hart for the identification of the varieties in that island are, in most features, applicable to Ceylon. These classifications do not, however, apply to all the varieties at present recognised in Ceylon, Java, Surinam, etc. and according to Preuss do not always strictly apply to the cocoa in Trinidad itself; in several countries it has become customary to attach the name of the country to the variety of cocoa exported, hence we learn of the Trinitario, Java-Criollo,† Java-Porcelaine, Nicaragua-Criollo, Surinam-cacao, Brussel-cacao, Moderboorn, etc., and a classification or key to the varieties is required for separate countries. The following are the systems drawn up by Morris and Hart and the characters of the varieties in Ceylon as described by Lock‡:—

* For previous article, see Bulletin IV. 10., Oct. 1906, p. 236.

** Reprinted from "*The Tropical Agriculturalist.*" Articles also appear in "*Theobroma Cacao, its Botany, Cultivation, Chemistry & Diseases.*" By H. Wright. Published by A. M., & J. Ferguson, Colombo,—London office, 52 Gracechurch St., E. C. All cocoa planters should have a copy of this book.—*Editor.*

† Mededeelingen omtrent de op Java aangeplante Cacaovarieteiten; L. Zehntner, Proefstation voor Cacao to Salatiga, 1905.

‡ Varieties of cacao in Ceylon, Circular, R.B.G., Vol. 2., No. 24, 1904.

Morris.	Hart.	Lock. Key to varieties. All the varieties here mentioned include both red and yellow sub-varieties as well as many other minor types:—
I.—Cacao Criollo ...	Class I. Criollo, or fine thin skinned	Beans plump, majority white or pale in section: Shell soft and relatively thin I. Criollo.
	1. Var. a. Amarillo	Beans very large, somewhat flattened 1. Nicaragua.
	2. „ b. Colorado	Beans half as large as 1, more rounded 2. Old Red.
II.—Cacao Forastero	Class II. Forastero or thick skinned cacao	Majority of beans purple in colour, shell relatively hard and thick. II. Forastero.
(*a*) Cundeamor verrugosa amarillo (yellow)	Var. *a*. Cundeamor verrugosa amarillo	Pods acuminate and bottle-necked, rough; beans of high quality, pale and rounded 3. Condeamor.
(*b*) Cundeamor verrugosa colorado (red)	„ *b*. Cundeamor verrugosa colorado	
(*c*) Liso amarillo ...	„ *c*. Ordinary amarillo	Pods various, usually not bottle necked; beans of fair to good quality. 4. Liso.
(*d*) Liso colorado ...	„ *d*. „ colorado	
(*e*) Amelonado amarillo .	„ *e*. Amelonado amarillo	Pods, ovate, nearly smooth, usually bottle necked; beans of lower quality, usually flat, and all purple. 5. Amelonado.
(*f*) Amelonado colorado	„ *f*. „ colorado	
	Class III. Calabacillo, or small podded, thick, smooth-skinned, flat-beaned	Pods ovate, smooth, small, not bottle necked; beans small, flat, and all deep purple 6. Calabacillo.
(*g*) Calabacillo amarilla	Var. *a*. Amarillo	
(*h*) Calabacillo colorado	„ *b*. Colorado	

FRUIT CHARACTERS.

Most of the varieties of cocoa grown in Ceylon are roughly divisible into the Old Red or Caracas, the Forastero or Hybrid and the Amelonado types. The classification given by Morris is simple, and that by Hart more detailed, though the latter does not, in my opinion, give a sufficiently minute sub-division to make it of every-day use on cocoa estates outside Trinidad. The ease with which new strains of cocoa arise has resulted in confusion, and it is a very difficult task to formulate a key to include the distinctive characteristics of the varieties existing in any one country where cocoa has been cultivated for twenty or thirty years. As far as fruit characters alone are concerned it would be no difficult matter to collect specimens which in point of size, shape, and colour form a more or less continuous series connecting the Nicaragua, Criollo, and Forastero types with one another; even the same tree in a single year or in successive years may produce fruits differing widely in external characteristics, and when one considers the characters of the rest of the vegetative system and those of the seeds, the mixed nature of the varieties now cultivated is manifest.

The classification of the cocoa varieties into three groups by Hart is, according to him, necessary, in order to distinguish between the Calabacillo and Forastero types. It is equally necessary to adopt a similar classification for the varieties in Ceylon and to perhaps omit the Calabacillo group (which is very rarely if ever, met with in this island) and give the Amelonado variety a separate class, as it is on all estates so markedly different in its shape, green-yellow colour and flat purple seeds from any other Forastero type.

In order to enable one to select the various types it will be necessary to deal very fully with the characters of the fruit wall and seeds.

FRUIT WALL.

Thickness.—The thinnest walls are found in the Nicaraguan and Caracas types and the thickest in the Forastero forms. The following figures show the thickness, lengths, circumferences and weights of several fruit walls of cocoa pods grown at Peradeniya:—

Variety.	Thickness of wall.	Length of wall.	Circumference in middle of fruit.	Average weight of 100 fresh fruit walls. lb.	oz.
Nicaraguan ...	12 mm.*	19·1 cm.	28·0 cm.		
Caracas ...	13 "	17·2 "	23·7	48	4
Forastero-Cundeamor	15 "	20·6 "	26·5	84	14
Amelonado ...	15 "	18·5 "	26·7 "	74	12

It is obvious from these records that the most wasteful variety of cocoa, as far as the thickness and weight of fruit wall are concerned, is the Forastero-Cundeamor and the most economical the Caracas or Nicaraguan type.

Colour.—The outer surface of the fruit wall is, unripe specimens, red or green, these changing during ripening to reddish-yellow or yellow respectively. In the Forastero group the fruits show all proportions of red and green inter-mingled with one another and even the Criollo fruits may be yellow or red. In Ceylon, the Amelonado variety is distinct in always having a green wall changing to pale yellow on ripening. Usually all the fruits on the same tree have a similar colour or distribution of colours,

In Trinidad, as indicated, by the classifications of Morris and Hart, each variety is sub-divided into red and yellow forms, and the same applies generally to the varieties in other cocoa-growing countries.

COLOUR OF OUTER SURFACE OF FRUIT WALL.

Variety.	When Unripe.	When Ripe.
Caracas ...	Usually red; frequently green	Usually reddish-yellow; frequently yellow
Nicaraguan ...	Red or green	Reddish-yellow or yellow
Cundeamor ...	Red and green	Reddish-yellow
Amelonado ...	Green	Yellow
Calabacillo ...	Usually red	Usually reddish-yellow

* 10 mm. = 1 cm.; 25 cm. = 10 inches.—*Editor.*

Shape and size.—In shape and size there is every variation between the long pod with acuminate apex—as in some forms of Nicaragua and Cundeamor,—to the short, ovate, broad base and blunt apex of Amelonado. Some forms are constricted at the base—Condeamor and Liso—others are wide at the base—Sambito and Amelonado—and others intermediate between these.

COCOA SEEDS.

In shape, size, and colour the seeds vary considerably. The shape is sometimes flat as in Amelonado, Calabacillo, and some forms of Nicaraguan, round and plump in forms of Caracas and Nicaraguan, long and more or less rounded in Cundeamor and other Forastero types. The size varies according to the part of the fruit occupied by the seeds, those at the ends usually being smaller—and also flatter—than those in the middle; the largest size is seen in the Nicaraguan and Caracas fruits, and the smallest in the Forastero types.

The colour of the seeds varies from white to deep purple in the same fruit or in fruits from different varieties. Generally the seeds of the Nicaraguan and Caracas varieties are white, those of the Forastero types white or purple, in varying intensity, and those of Amelonado and Calabacillo all deep purple. There is, however, a great variation in the number of white seeds in the first mentioned varieties, and more often than not the cocoa trees on plantations in Ceylon possess fruits with white and purple seeds, or with all the seeds purple. It is very rare that all the seeds in the fruits from one tree are white, even with the Caracas and the more recently introduced Nicaraguan forms, and much of the unevenness in the finished product is to be attributed to this unfortunate variation.

It has been shown by Lock* that out of nearly seven hundred fruits of the Caracas variety about 58 per cent. of them possessed white seeds only, 40 per cent. possessed white and purple seeds, and 1·8 per cent. possessed purple seeds only. In the particular set of fruits referred to 84·7 per cent. of the seeds were white and 14·2 per cent distinctly purple, thus showing that though the reputed original character still predominates, the mixed seeds are becoming very prominent. In most cocoa-growing countries the Cacaras or Criollo type is supposed to possess white seeds only. Similarly a large per centage of the seeds of the Nicaraguan, which are commonly supposed to be white, were found to be mixed, but the white remains predominant in some types of this group. The Forastero types always possess coloured seeds, and though as many as 18·8 per cent. of the fruits contained purple seeds only, none were seen with white seeds only; the seeds of 180 fruits of this group possessed 61·8 per cent. of purple seeds and 37·4 per cent. of white ones, thus proving the existence of a definite quantitative difference between the Forastero and the preceding Criollo types. The Amelonado and Calabacillo fruits possess 100 per cent. of purple seeds, white ones being unknown in Ceylon.

* R. H. Lock, Circular, R. B. G.

COLOUR OF SEEDS.

Variety of Cocoa.	Fruits with white seeds only.	Fruits with purple seeds only.	Fruits with mixed seeds purple and white.	Per centage number of white seeds in fruits.	Per centage number of distinctly purple seeds in fruits.
	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
Nicaraguan ...	48·2	18·8	33·0	64	36
Caracas ...	57·9	1·8	40·3	84·7	14·2
Forastero ...	00·0	18·4	81·6	37·4	61·8
Amelonado ...	00·0	100·0	00·0	00·0	100·0

According to Hart, the Criollo or Caracas variety in Trinidad possesses white or nearly colourless seeds, a feature associated with the seeds of the same variety in Java, Ceylon, and Central America, and also by the produce of *Theobroma pentagona;* reference to the per centage number of purple seeds is not made, though it may be assumed that on most estates cultivating many varieties they occur. Regarding Nicaraguan, Hart states that though the Criollo is the predominant type and the seeds are usually white in section, there appears to be a perceptible increase in the colour of the seeds and this he associates with the proximity of the Criollo with the Forastero types. The Venezuelan* cocoa is mainly white-seeded and produces a cured cocoa of good colour and distinct high-class flavour without any bitter taste.

The variation in thickness and weight of the seed integuments has been dealt with elsewhere, and it is only necessary to mention that the thinnest integuments are found around seeds from Nicaraguan and Caracas fruits, and the thickest in the Amelonado and Forastero types.

THE PARTS OF A COCOA BEAN, AND SEED SELECTION.

The fresh cocoa seed consists of a watery white pulp on the outer surface of a tough integument, the latter enclosing two stout cotyledons which form the greater part of the embryo and are usually known as the kernel. Roughly the kernel is only responsible for half the total weight of the fresh seed, the pulp of the latter often being considerable. The weight of the seeds varies with the variety and other factors, the large plump ones being much heavier than the others. The weight of the cured seeds of different varieties is not constant, but the following table shows the average weight of several thousands of seeds of four varieties grown at the Experiment Station, Peradeniya :—

TABLE I.

Variety.	Weight in grams.
Forastero-Cundeamor ...	1·01 to 1·26
Caracas ...	1·19 to 1.35
Amelonado ...	1·00 to 1·10
Nicaraguan ...	1·31 to 1·80

* Annual Report, Botanic Department, Trinidad, 1904.

According to Semler* the following are the weights of 100 cocoa beans from various countries :—

TABLE II.

Kind.		Weight in grams.
Trinidad ordinary	...	98
„ fine	...	123·2
„ extra-fine	...	178·7
Grenada, fine	...	131·0
Caracas	...	130·3
Dominique	...	110·0
Surinam fine	...	122·0
Bahia	...	118·0
Mexican	...	136·5
African	...	128·5

Semler concludes that the average weight of a cocoa bean is about 1·2 grams ; a comparison of the weight of the seeds from varieties grown in any country should always be made. Regarding weight only, the Caracas and Nicaraguan varieties in Ceylon compare favourably, but the inferiority of the Amelonado and Forastero types is equally pronounced.

PROPORTION OF INTEGUMENT AND KERNELS.

This is an important subject in connection with seed selection and is well worthy of consideration. The integuments of beans of the Caracas or Nicaraguan varieties are usually, but not always, thinner than those of the Amelonado or Forastero types, and the proportionate weight of integument to kernel is usually lowest in the round plump samples. Actual weighings show very contradictory results owing to the variable amount of pulp, absorbed moisture, and dirt attached to the outer surface of the integument.

The following table shows the average proportionate weight of the integuments and kernels of different varieties of 100 cured cacao beans at Peradeniya :—

TABLE III.

——	Weight of kernels only.	Weight of integuments.	Total weight.	Per centage weight of integuments.
Caracas ...	116·2 grams.	10·8 grams.	127 grams.	8·5
Forastero-Cundeamor	103·0 „	10·3 „	113·3 „	9·0
Amelonado ...	94·7 „	10·3 „	105 „	9·8

The integuments on badly washed or dirty beans vary considerably in weight, and in many such samples the proportionate weight of the integuments around Caracas beans is higher than that around clean beans of the Amelonado type.

According to the researches of Girard, Heisch, and Zipperer, the ratio of the weight of integuments to that of the beans from different countries is as given in the following table ; the figures by Heisch are for the final product and the others for the raw beans :—

* Le Caĉaoyer, H. Jumelle, p. 40.

TABLE IV.

	Girard.	Zipperer.	Heisch.
Trinidad	9·82	14·68	15·50
Caracas	15·85	15·00	13·80
Puerto-Cabello	13·21	12·28	—
Guayaquil	10·32	—	11·50
Surinam	—	14·60	15·50
Para	10·39	—	8·50
Bahia	—	—	9·60
Ariba	—	18·68	—
Haiti	8·93	—	—
Martinique	8·97	—	—
Cuba	—	—	12·00
Grenada	—	—	14·60

The Ceylon beans have been well washed and the integuments, having the minimum pulp and dirt, weigh less than other kinds; the integuments of Ceylon beans constitute from 8 to 10 per cent. of the total weight of the cured bean.

It is obvious from the foregoing figures that in Ceylon there is a wide variation in the average weight of cured beans from fruits of different varieties, hence those with the minimum weight must either bear better cocoa, be more suitable for cultivation, or give larger crops of fruit; otherwise they should be eliminated in the selection of seed parents. It has also been shown that the different varieties have constant characters in the thickness or weight of the skin, cuticle, or integument surrounding the seeds; those varieties having the larger proportion of integument are obviously inferior.

NUMBER OF SEEDS IN FRUITS.

It is now necessary for us to determine the average number of seeds per fruit and the average number of fruits borne by the different varieties.

The number of seeds per fruit varies considerably, but the following table indicates possible averages :—

TABLE V.

Variety.	Number of fruits.	Range in number of seeds per fruit.	Average number of seeds per fruit.
Amelonado ...	100	16 to 52	40·87
Caracas ...	100	16 to 42	31·45
Nicaraguan ...	175	24 to 36	28
Cundeamor ...	100	21 to 50	36·26

If the figures on tables I, III, and V, be compared, it will be noticed that the Nicaraguan and Caracas types have the heaviest seeds and lightest integuments respectively, but produce a lower average number of seeds, per fruit, than the Amelonado or Forastero-Cundeamor types. The Amelonado fruits contain the maximum number of seeds, but the latter are very light in weight and have comparatively heavy integuments. These results prove that in weight of cured cocoa from 100 fruits, integuments and kernels together, the Amelonado often comes first.

TABLE VI.

Variety.	Average number of seeds per 100 fruit.	Average weight of one cured bean.	Average total weight of cured cacao from 100 fruits.
Nicaraguan ...	2,800	1·55 grs.	4,340·00 grs.
Caracas ...	3,145	1·27 „	3,994·15 „
Cundeamor ...	3,626	1·13 „	4,097·38 „
Amelonado ...	4,087	1·05 „	4,291·35 „

To complete the comparison it would be necessary to give figures illustrative of the average number of fruits annually produced on trees of the four varieties, of known age, and when cultivated under identical conditions. Unfortunately no such figures, of a reliable nature, are at present available, and we are compelled to consider only general observations on this subject. Observed trees of the Nicaraguan variety, planted in 1895, gave averages of 25, 50, and 70 fruits each in the years 1903-04; Cundeamor trees have given from 50 to nearly 200 fruits during the same period; Amelonado 30 to 90; and some trees of Caracas 30 to 50 during one year. Such figures, however, are of very little value, and our purpose can best be served by determining how many cocoa fruits must be produced, per tree, to give the same weight of cocoa obtainable from 100 fruits of—say, the Cundeamor type.

Variety.	Average total weight of cured cocoa, from 100 fruits.	Number of fruits required to produce cocoa of weight equal to that from 100 Cundeamor fruits.
Amelonado ...	4,291·35 grs.	95
Cundeamor ...	4,097·38 „	100
Caracas ...	3,994·15 „	102
Nicaraguan ...	4,340·00 „	94

It may be stated that, as far as the *number* of fruits per tree, per year, from each of the above varieties is concerned, the Cundeamor and Amelonado come first, and Caracas and Nicaraguan second; this is only an approximation and does not mean that the order of productiveness of Caracas or Nicaraguan cannot be brought very near to that of the Cundeamor by good cultivation. The highest valued cocoa, by weight, is undoubtedly the large plump beans of Nicaraguan and Caracas, then the Cundeamor, and lowest the Amelonado. Judging from current values, the Nicaraguan, Caracas, Cundeamor, and Amelonado cocoa may be stated to have approximate values in the ratio of 70, 65, 60, and 50. The Amelonado variety, though it is easily cultivated and gives a good crop, produces thin, flat bitter, and deep-purple seeds, and seems to be the least desirable to cultivate.

FERMENTATION OF COCOA.

OBJECT OF THE PROCESS.

Briefly stated, the object of fermenting cocoa seeds is to remove the sugary pulp surrounding them, to promote chemical changes within the kernels, to convert the bitter astringent taste into a sweet one, and to improve their colour, fracture, and flavour. Such changes are brought about when large numbers of seeds, fresh from the fruit, are heaped together and allowed to remain in contact with one another. Though the process involves a relative high temperature it is very rare that the latter destroys the embryo of the seed ; to a certain extent fermentation is a continuation of the processes commenced in the seeds after maturity. Ordinary fermented seeds, if dried under unfavourable conditions will germinate, the prevention of such developments being one of the main objects of curing ; this proves that the fermenting of cacao does not involve chemical changes harmful to the vitality of the seeds.

The necessity of, and improvement in quality effected by, the ordinary fermentation of cocoa are generally acknowledged ; nevertheless, some countries do as little fermenting as possible, and in some places this operation is entirely neglected. According to some authorities the purple colour and bitter taste of the unfermented dried seeds are wanted by some markets.

In 1902, several experiments were made at the Experiment Station, Peradeniya, with the object of effecting a good curing of seeds which had been fermented inside the fruit. In the first experiment the fruits were exposed to the sun for seven days until the wall was brown and brittle ; the seeds were then cured in the sun, some after washing, others without washing. The cured seed prepared in this manner was dark in colour externally ; internally it was very uneven in colour and not at all brittle. In a second experiment the fresh unbroken fruits were placed in a curing house, and kept at a temperature of about 100° F. for three days. The beans, fermented under such conditions, were subsequently cured in the sun as in the first experiment, and with very nearly the same results. In a third experiment fresh seeds were exposed to the sun without any fermenting, but with poor results. In none of these experiments did the results obtained justify the change in our method of fermenting. All the seeds which were fermented inside the fruit, or cured without being fermented, had to be placed along with the "black" cocoa, owing to the pliable nature and uneven colour of the substance of the seed.

METHODS OF FERMENTING.

It is now necessary to describe the various methods of fermenting adopted in different cocoa-growing countries. In Ceylon most cocoa planters adopt what may be termed the natural method of fermenting, which consists of heaping the fresh seeds on the floor or in receptacles and covering them with leaves of the banana, ordinary cloth, or layers of these alternating with layers of earth. The fermenting floor is usually built with a slope, so that the watery products may escape during fermentation. Each heap may consist of four or more bushels of fresh seeds, which are turned over every day to prevent the temperature rising too high and to ensure an uniform product ; a period of thirty-six hours to five days or even longer is allowed for fermentation according to the variety dealt with and the circulation of air maintained through the heated mass, after which the seeds are washed and then cured, either in the sun or in rooms supplied with hot air. The cocoa planters in Ceylon do not usually separate the different varieties from one another, but more often than not ferment the seeds from fruits of the Caracas, Forastero, and Amelonado varieties in the same heap. The only selection usually made is in fermenting seeds from unripe or diseased fruits in special heaps ; these are never fermented in the same heaps as the seeds from healthy mature pods. When the fruits are divided into classes comprising (1) mature healthy fruits, (2) immature healthy fruits, and (3) diseased fruits, and each fermented in separate heaps there is a slight advantage, but it is much more important to separate the first group into its component varieties. If all the varieties are fermented in one heap, the fermentation is very uneven, and the final product cannot be uniform in quality.

On some estates the coolies are trained to detect, in the freshly fermented and washed material, the purple seeds from the Forastero and Amelonado fruits from the white seeds of the Caracas variety, the former having much thicker integuments than the latter and being much darker in colour ; the colour of the kernel can to some extent be distinguished through the integument in the freshly-washed seeds. This allows one to obtain uniform samples of cured cocoa, but it does not obviate the uneven fermentation. The rapidity of fermentation depends to some extent on the thickness of the seed integuments ; the Nicaraguan and Caracas seeds have very thin integuments, and fermentation is consequently effected much more rapidly than in the thicker-skinned seeds of the Amelonado, Calabacillo or Forastero varieties. The thick-skinned, flat bitter, and purple seeds of Amelonado fruits require a longer period for fermentation than any other kind cultivated in Ceylon, and it appears to be erroneous to ferment all varieties in the same heap.

In addition to the ordinary or natural fermentation of cocoa other methods have been brought forward, which are dependent upon maintaining the fermenting heap of seeds at a constant temperature. At the Experiment Station, Peradeniya, a series of tanks, lined with cement, have been made ; on two sides of each tank are a large number of holes with an average diameter of 7·5 cm.(three inches); through each hole a perforated bamboo is pushed, the latter being of such a length as to stretch from one side of the tank to the other. By this means air can be let into or drawn through the fermenting heap according to requirements ; the floor is made with a slope to one point, where a perforated sieve is placed, to allow the watery products of fermentation to escape.

M. Schulte* has devised a fermenter which allows the operator to maintain the fresh cocoa seeds at a constant temperature of 60° C. ; in this method the cocoa is placed in specially made wood receptacles, positioned one above the other and each made to carry six or more frames between which air spaces exist. The fresh seeds are arranged to a depth of 10 cm. on the frames, and these are then put into the fermenter. The fermenter consists of two chambers fitting tightly together, and is maintained at a tempera-

* Journal d'Agriculture Tropicale, No. 52, Oct. 31, 1905.

ture of 60° C. by conducting channels which allow the hot air to circulate from grates disposed at one end of the apparatus. Thermometers indicate when it is necessary to increase or decrease the temperature. It is asserted that by such an apparatus the cocoa is fermented in such a manner as to produce a homogenous product, and one which is freer from acidity than most of the cocoa placed on the market. M. Maurice Montet in his criticism on the apparatus and method designed by M. Schulte states, that though the results ascribed to this process are possible, the expense and the skilled assistance necessary to supervise the work, are such as to make the process of little value to cocoa planters in most parts of the tropics. Furthermore, it has been pointed out that the cocoa on the public market is often classed and valued more according to the countries from which it has been obtained than the method of fermentation adopted ; this, though correct to a certain degree, should not discourage the introduction of new and better methods of fermenting, as it is obvious from the present range in value of cacao from any one country that the better qualities will ultimately receive recognition.

FERMENTING IN TROPICAL AMERICA.

The time taken to effect a good fermentation in parts of Central America varies accoring to the variety dealt with and the methods adopted. In Nicaragua the seeds from Criollo and Lagarto fruits are fermented for two days and the Trinitario seeds about four to five days ; in Salvador the seeds are usually fermented for one or two days, and the same length of time appears to be allowed for the varieties in Guatemala.

FERMENTING IN SURINAM, VENEZUELA, ETC.

Preuss* is of the opinion that the cocoa varieties grown in Cameroon are not inferior to those cultivated in Surinam, though the cocoa exported from the latter place is the better one. He attributes the bitter taste and sour smell of much of the Cameroon cocoa to the want of efficient fermenting, and ascribes the good qualities of the cocoa from Surinam to the systematic fermenting which is adopted. The fermenting chambers in Surinam consist of series of compartments, often eight in series, and some measuring 1·5 metres in breadth, 2·25 m. in depth and 1·7 m. in height ; these chambers are made of wood, provided with an intervening air space between one another, and constructed with sloping floors. In fermenting, one box or chamber is left empty ; the others are filled with wet cocoa, often to a depth of one metre, and the cocoa is covered with banana leaves, and the box is then closed. The cocoa is allowed to ferment in this condition for one day; when that from the chamber next to the empty one is transferred to the latter ; the contents of each box, after each empty one has been well washed, are transferred to the next empty one, and by this means the cocoa is well mixed and superfluous sweatings removed. Each box is again allowed to retain the fermenting cocoa for one day, when the same process is again

* Expedition nach Central und Südamerika, by Dr. Paul Preuss, 1901.

gone through; at the end of five to eight days fermentation isusually considered complete, though only long experience can teach those responsible when the desired changes have been induced.

In Surinam a temperature above 45°C. is considered to be detrimental, and all fermenting chambers are situated in places protected from the wind. The sweatings are, by means of the sloping floor, conducted to an open channel constructed of glazed earthenware, and are thus allowed to escape from the fermenting heaps of cocoa. The best results are believed to be obtained by fermenting large instead of small quantities of cocoa; the Surinam planters believe that the changes are more complete and better when fermenting is done in moist than in wet weather.

According to Chittenden, in Venezuela*:—"The conuquero puts his beans to drain, and forthwith exposes them to the sun for say five or six hours, then heaps and packs them up to sweat afresh until the following day, when they get five or six hours more sun and so on. Another contrivance of the small grower is that of bagging the cocoa at the end of the day whilst still hot from exposure to the sun and sweating it during the night."

In Mexico, according to one authority, holes are made in the earth and covered with sacks or leaves of bananas; in these the seeds are placed and then covered with sacks or leaves; the material is then left till the cocoa is sufficiently fermented. In Surinam, according to the same authority, the cocoa is thrown into heaps in wooden sheds and then covered with banana leaves. In certain countries of South America the seeds are put into leather bags to ferment, and left suspended till the changes are complete; large casks are often used in which the fermented cocoa is placed, and the casks rolled to aid in the mixing of the fermented mass. In Granada and Trinidad, according to Van der Held, the Strickland method is employed; this requires a transference to three separate receptacles for different fermentations, the fermentation often requiring a dozen days.

FERMENTATION IN JAVA.

In the opinion of Van der Held, after his experience in Java, the cocoa ferments best in receptacles of wood with the minimum quantity of air. It is not absolutely necessary that these should be constructed of closed walls, but they should be capable of being covered, and situated in places sheltered from the wind. In Java the fermentation is sometimes made in movable receptacles, the wooden walls of which are perforated in order to allow the by-products of fermentation to flow away. In the same island sometimes fixed receptacles of large dimensions are used. If the production of cocoa is not very considerable, Van der Held recommends the use of small movable receptacles, which can be easily cleaned. For a large estate he recommends the following:—

Place the fermenting tubs or troughs in an amphitheatre, and have the walls made of movable planks capable of being slid into the grooves of supports. Each receptacle is two metres long,

* Cacao, by J. Hinchley Hart, Trinidad, 1900.

one broad and one deep, and is capable of holding ten piculs of fresh seeds. They should be arranged in such a manner as to be on the same level, in a row, and their number increased according to requirements. When the seeds have been ten to twelve hours in the upper trough they are transferred to the trough beneath, this being easily done on account of the movable planks forming the walls. When the cocoa in the upper chamber is to be put below it is only necessary to raise the partition. Van der Held obtained the best results by changing the receptacle twice a day in order to avoid heating; this was done between seven and eight in the morning and four and five in the afternoon. The bottom of the chambers is perforated, the openings being half-a-centimetre in diameter; these allow the liquid to flow away. A gutter is fixed to the floor to conduct the liquids to a central point should it be required for vinegar production.

FERMENTATION IN THE WEST INDIES.

In the Jamaica Bulletin for August, 1900, the following process is described:—"Accumulate at least 500 pods before breaking; you will get better results by having larger quantities. A simple box is made one foot deep and varying in length and width according to the quantity of cocoa; the contents of 1,000 pods require a box 2 ft. 6 inches long, 2 ft. wide and 1 ft. deep (inside measurements) and will fill such a box to a depth of 9 inches. It must be constructed so that no iron nails come in contact with the cocoa, for iron is attacked by the "sweatings" forming a black liquor which discolours the cocoa. The bottom of the box is bored with many holes, and is raised from the ground on two blocks of wood. It should be under cover and in a clean place free from dust. No lid is required. After filling with cocoa, cover with a piece of clean sacking. Each morning turn up the whole mass with the hands; the cocoa which was at the side and bottom being now towards the centre. If the quantity is small, turn out to dry on the fifth day, if larger (say over 2,000 pods) on the sixth day, *i.e.*, after five full days' "sweating." Scrub out the box thoroughly, and wash and dry the sacking before beginning a fresh batch. Thus by a short fermentation of a shallow mass, with plentiful access of air you will get a better results than by keeping the mass closely packed together in a deeper vessel. The close packing of the mass does not make it hotter; on the contrary the more air reaches the mass, up to a certain limit, the hotter the cocoa will become. As prices stand at present you will not find it advisable to ferment for a longer time, but on the other hand I cannot recommend you to shorten the time by a single day as your cocoa would then retain too much of its original bitter flavour." This method is interesting, but whether it is largely adopted in Jamaica or elsewhere is not quite clear.

FERMENTING COCOA IN TRINIDAD.

The fermenting of the cocoa in Trinidad is, according to Preuss, carried out on very much the same principle as in Surinam, though fermenting houses in the former place are frequently only protected by a roof to keep the rain off the boxes. Many methods are adopted in the island of Trinidad. One fermenting house on La Réunion Plantation, Trinidad, consists of sixteen compartments each 1·5 metres high and about as broad, and 2 metres long. The walls are made of wood, and between each two boxes and along the sides is a layer of clay and dry grass, sometimes about 20 cm. thick, to act as a non-conductor of heat: each compartment is supplied with a lid. The boxes are filled to a depth of about one metre with fresh wet cocoa, covered with a layer of banana leaves and then closed. One box is kept empty so that the seeds can be transferred at any time, and the used boxes washed out every one or two days. The seeds are first fermented for one or two days after which they are transferred to an empty box and fermented again for a similar period. The transference from box to box is made every one or two days until fermentation is complete, eight days being generally required for ordinary Forastero seeds and fourteen days for Calabacillo.

In some districts the cocoa is fermented in bags suspended in holes in the earth, the contents being repeatedly kneaded without the sack being opened; by this means fermentation is said to be effected in about five days.

Another method is that associated with Cradwick,* which consists of using a cask, perforated at the bottom to allow the liquid to escape; the floor is covered with a thick layer of dried banana leaves (25 cm. in thickness), and the walls are covered with a layer of the same material. The wet seeds are placed in the cask and then covered with banana leaves and allowed to ferment; after they have fermented for about two days, those in the upper part are taken out separately and subsequently returned first to the empty cask so as to be at the bottom during the following days, and those which were previously at the bottom now occupy the upper part. This operation is again repeated after two days' fermenting. This method is said to be suitable for fermenting cocoa from about one thousand fruits, but if more are used an undesirable temperature may occur; if the quantity is less more banana leaves are used and the cocoa often weighted during fermentation.

FERMENTATION IN AFRICA.

The report† of one company operating in Africa states that in the preparation of cocoa very good results have been obtained by fermenting the cocoa for six days, the cured product having lost much of its bitter taste and secured a higher valuation. The same persons also report that the washing of cocoa, though it always gave them a clear bright colour, has now been dispensed with, as by omitting this operation they increase their weight of cocoa by 8 to 10 per cent.

In West Africa, according to Johnson, the old plan of preparing the beans for market by simply drying them in the sun has been abandoned everywhere in favour of the fermenting method intro-

* Bulletin of the Botanical Department, Jamaica, III. 1. Jan., 1896, p. 15.

† Kamerum Land-und Plantagen-Gesellschaft, Hamburg, p. 481, Der Tropenflanzer Nov. 1902.

duced by the Government Botanic Department. "The beans are now placed in heaps upon mats and then covered up with mats weighed down with stones, and left for four days if this takes place upon the same day the pods are plucked, but for three days if upon the following day; after which they are washed in baskets."

Various fermentation experiments have been made with the purple and bitter seeds of varieties cultivated in Cameroon, and reports have been issued which are, to a certain extent, somewhat contradictory. One authority,* however, asserts that by fermenting the seeds in a particular manner it is possible to almost entirely remove the bitter unpleasant taste so frequent in purple seeds fermented in the ordinary manner.

LENGTH OF FERMENTATION.

Though this process is considered to be of vital importance in the production of good kinds of cocoa, there is a very conspicuous variation in the time allowed for fermentation, and most people calculate when fermentation is complete by the appearance of the material to the naked eye and the odour of the mass of seeds. Cocoa is sometimes only fermented for two days, at other times the changes are allowed to continue for twelve or even more days, and in all cases cocoa of good quality is apparently produced. It may, however, be considered safe to state that those varieties having thin integuments and white cotyledons require the minimum time, and those with thicker integuments and purple cotyledons the maximum; to the former class belong the Caracas, Nicaragua, and some forms of Forastero, and to the latter the Calabacillo, Amelonado, and inferior kinds of Forastero.

The length of time required can only be determined by practice as the chemical and physical characters of the seeds of the same variety vary according to the plant, its diseases, and to some extent climatic conditions. It is asserted by some that the pulp which surrounds the seeds contains, in Java, more water during the west monsoon than in the east monsoon, and that in wet weather the fermentation takes place more rapidly. The time required for fermentation will also vary according to the method employed, the market for which the cocoa is prepared, and the quantity being fermented. Large quantities of cocoa ferment quicker than small quantities, and due allowance must be made for this.

In parts of Java the cocoa is allowed to ferment two nights and sometimes even only one night on account of the condition of the seeds from diseased specimens. After a night of fermentation the seeds from diseased specimens may germinate and produce cocoa which is for the most part broken, very light, and of bad quality. Usually healthy cocoa is allowed to ferment three days.

In Java the Criollo does not usually require to be fermented more than four days. The Criollo or Caracas type in Ceylon and

*Zur Kakao—Fermentation, by Dr. A. Schulte im Hofe. Der Tropenflanzer, May 1901.

Trinidad does not usually require more than two days, though it is always fermented for five; the Forastero a day longer, and the Amelonado four or five days. Preuss states that the finest and sweetest cocoa requires twenty-four hours and the bitter kind six to eight days. Fermentation is considered complete when on cutting a seed transversely one notices that the cotyledons have separated and the sugary liquid occupies the spaces within the seed. On drying, the beans may be brown in colour and sweet to the taste or purple and bitter to the taste, the former being the desired characteristics on most European markets.

PERIODICITY OF THE COCOA TREE.

It is necessary to consider the periodicity of the vegetative and reproductive system of the cocoa tree before dealing with the subject of its cultivation and the harvesting of the crop. There are reasons for believing that the most successful results in cultivation will probably be obtained by taking advantage of the normal periods of varying activity which characterise the different stages in the life of the tree rather than by the application of methods or substances to stimulate parts of the tree during their periods of minimum activity.

The cocoa trees on a large area produce leaves, roots, flowers and fruits throughout every month of the year, and many cultivators have adopted methods with the idea of making the trees more productive at periods of the year which do not agree with those of the natural periodicities. It is possible, by affecting the water supply to the roots and by the pruning of branches and roots, to considerably change the periodicity of vegetative and sexual tissues, but it is a course which, if not carried out very carefully, may be accompanied by a serious reduction in the cocoa crop.

FOLIAR AND ROOT PERIODICITY.

In all tropical areas heat and light are intense, and these, together with the heavy rainfall of many places, result in a conspicuous growth of vegetation at most times of the year. Though the climatic changes are not analagous to the seasons of a temperate zone, the plants in the tropics are just as subject to periodical changes ot rest and activity as those of cooler zones. The periodicities of the climates in cocoa-growing countries differ considerably, and the remarks here given have reference mainly to the cocoa-trees in the Peradeniya district of Ceylon ; a change in climatic periodicity is usually followed by one of plant periodicity.

The leaves of the cocoa tree show an increase in number year by year until by about the eighth or tenth year a standard size appears to be attained. Throughout these first years the foliar production is irregular, but as time goes on there is a tendency to produce a large number of new leaves during two or three periods each year. On a cocoa estate with all the trees in bearing it is impossible to find a healthy specimen absolutely leafless even during the hottest and driest part of the year; most of the trees produce a few leaves every month in the year, but reserve their periods of maximum foliar production for the months of February, March, and September, considerations to be kept in mind when dealing with the periodicity of the flowers and manurial operations. The periodicity in the root growth of cocoa trees in Ceylon is but little understood; the rootlets are formed during every month in the year, but during April-June and again in October-November there appears to be increased activity in this part of the plant. The general observations made on this part of the subject point to a periodicity of root activity in association with that of the foliage.

FLOWER PERIODICITY IN 1903.

An investigation has been made on the periodicity of flower production with a view of determining its relationship to that of the fruits and rainfall. Forty-two trees were under observation each day in the years 1903, 1904 and 1905. The flowers were plucked after they had opened, so that the physiology of the plant would be disturbed as little as possible. It may be asserted that the removal of these newly-opened flowers would probably lead to a more prolific appearance of flowers at a subsequent date, but when one considers that an average tree produces only about sixty to eighty mature fruits in the whole year, the procedure adopted cannot be expected to greatly alter the flower periodicity in question. Not more than 0·2 to 0·4 per cent. of the flowers produced on a cocoa estate planted 12 × 12 feet and yielding 3 cwt. of cured cocoa per acre, per year, develop into mature fruits; they are easily detached when in full bloom or after withering. The number of flowers produced in the year 1903 varied from 178 on tree number 5,725 to 33,534 on tree number 5,782. The average number of flowers produced, per tree, for 1903 was 5,666, equal to 1¾ million per acre. In order to show the variability, the following figures are quoted for six selected trees:—

TABLE SHOWING THE FLOWER PERIODICITY OF SIX SELECTED CACAO TREES DURING 1903.

	Tree No. 71.	Tree No. 5,786.	Tree No. 5,782.	Tree No. 5,768	Tree No. 5,798.	Tree No. 5,431
January ...	67	65	165	113	127	43
February ...	388	245	353	34	17	7
March ...	1,992	372	4,269	479	704	91
April ...	1,292	438	4,578	334	1,428	33
May ...	2,978	2,439	7,050	1,507	7,605	641
June ...	1,576	756	1,531	150	495	144
July ...	1,950	1,829	3,509	272	476	123
August ...	1,391	442	2,148	214	193	97
September	1,285	423	3,778	595	308	60
October ...	1,246	755	3,376	445	89	36
November	1,192	496	1,639	232	63	15
December	998	944	1,138	276	52	26
Total ...	16,355	9,204	33,534	4,651	11,457	1,316

The following table gives (1) the total number of flowers produced on the forty-two trees under observation; (2) the monthly average of flowers per tree for the year 1903 :—

		Total Flowers for forty-two trees.		Average No. of flowers per tree.
January	...	4,281	...	102
February	...	4,616	...	109
March	...	25,562	...	608
April	...	18,616	...	443
May	...	71,839	...	1,710
June	...	14.982	...	356
July	...	21,811	...	519
August	...	15,347	...	365
September	...	21,124	..	503
October	...	17,191	...	409
November	...	11,080	...	264
December	...	11,556	...	275
Total	...	238,005		

FLOWER PERIODICITY FOR 1904.

The observations were continued on the same trees as in 1903, and the following are the records showing (1) the total number of flowers produced on the forty-two trees under observation; (2) the monthly average of flowers per tree during 1904 :—

	Total flowers for 42 trees.		Average No. of flowers per tree.		Average No. of flowers per tree.
	1904.		1904.		1903.
January ...	11,799	...	280	...	102
February ...	12,953	...	308	...	109
March ...	29,250	...	696	...	608
April ...	57,287	...	1,363	...	443
May ...	84,011	...	2,000	...	1,710
June ...	84,338	...	2,008	...	356
July ...	32,345	...	770	...	519
August ...	11,326	...	269	...	365
September...	15,567	...	370	...	503
October ...	24,852	...	591	...	409
November ...	19,971	...	475	...	264
December ...	17,791	..	423	...	275
Total	401,490	...	9,553	...	5,663

The average number of flowers produced, per tree, for 1903, was 5,663, equal to 1¾ million per acre at 300 trees to the acre. The average number of flowers, per tree, for 1904, was 9,553, equal to 2 4-5 million per acre, per year. In 1904 the trees were much freer from disease. An interesting case was observed on tree numbered 4,031 on plot 3. This tree produced flowers every month in the year, but on the 20th June, 1904, it possessed no less than 27,632 flowers, the counting of which occupied the attention of two men 1½ days. On the 20th July there were only fifteen young fruits on the same tree, and throughout the year the tree did not produce one hundred fruits.

In order to show the variability, during 1904, the following figures are quoted for six selected trees :—

	Tree No. 71.	Tree No. 5,786.	Tree No. 5,782.	Tree No. 5,768.	Tree No. 5,798.	Tree No. 5,434.
January ...	1,036	674	1,429	296	110	34
February ...	1,074	929	1,505	257	1,191	46
March ...	2,764	1,547	3,191	820	284	160
April ...	5,032	3,048	5,076	1,944	600	379
May ...	9,079	3,256	9,875	2,744	1,529	509
June ...	9,508	5,499	7,793	2,127	1,241	756
July ...	2,898	1,743	1,537	963	525	522
August ...	1,376	391	1,189	201	130	57
September ...	1,519	666	1,836	187	153	149
October ...	2,232	1,017	2,953	444	234	203
November ...	1,973	674	2,051	376	213	54
December ...	1,335	572	1,333	411	204	62
Total ...	39,826	20,016	39,768	10,770	6,414	2,931
Total for the same trees during 1903	16,355	9,204	33,534	4,651	11,457	1,316

The data for the flower production during 1905, on the same trees is now given for comparison with previous years.

MONTHLY FLOWER PERIODICITY, 1905.

	Total flowers for 42 trees. 1905.	Average number of flowers per tree. 1905.	1904.	1903.
January ...	13,524	322	280	102
February ...	15,893	378	308	109
March ...	19,773	470	696	608
April ...	19,999	476	1,363	443
May ...	55,752	1,327	2,000	1,710
June ...	157,913	3,759	2,008	356
July ...	50,730	1,207	770	519
August ...	25,354	603	269	365
September ...	10,697	254	370	503
October ...	5,650	134	591	409
November ...	40,946	974	475	264
December ...	88,879	2,116	423	275
Total ...	505,110	12,020	9,553	5,663

NUMBER OF COCOA FLOWERS ON ESTATES.

These observations prove that there is not a month in the year when flowers are not produced if a minimum of say ten trees is chosen. On six out of the forty-two trees selected no flowers were produced during certain months of 1903, these months including only February, March, and April.

The total amount of flowers produced on a cocoa estate may be from 1,700,000 to 3,606,000 per acre, per year (300 trees to the acre). A yield of 3 cwt. of cured cocoa per acre means that at the most only about 8,000 flowers develop into mature fruits on each acre per year, or, in other words, a balance of 1,692,000 to nearly 3,600,000 flowers, per acre, per year, are at present of no value to the average cocoa planter. A large number of flowers appear to have been fertilised, but the expanding fruits soon turn yellow and shrivel; for the year 1903 out of a total of 569,738 promising fruits, no less than 288,205 were of this class.

These facts show that there is ample opportunity for research in connection with flower pollination and fertilisation. The cocoa trees on which the these observations were carried out were normal; it would have been possible to select much more vigorous plants, and to show that the average number of flowers produced was in excess of those under observation for that year.

For the present it is important to note that the period for maximum flower production was in the months of April, May and June, and that this was preceded or followed by minor periods of floral activity in the years 1903, 1904 and 1905.

VANILLA INDUSTRY IN THE SEYCHELLES.

The following particulars of the vanilla industry in the Seychelles Islands are given in a Colonial Office report for 1905 :—

EXPORTS OF VANILLA.

		1904	1905
		Rs.	Rs.
United Kingdom	...	130,592	137,185
France	...	148,446	136,462
Mauritius	...	3,987	64
Switzerland	...	8,400	8,400
Germany	...	——	765

The striking feature in the foregoing statement is the continued collapse of vanilla, the staple export of the Colony for many years. Vanilla may have a future; in no place are the conditions of nature more favourable than in Seychelles, but for the present it is of little value, and the crop of 1906 is so small that it cannot be expected to exceed 30,000 kilos. Vanilla has long held the pride of place at the head of the products of Seychelles. In 1905 it has been displaced by coco-nut products, which have been exported to the value of Rs. 413,951, whereas vanilla has fallen in value to Rs. 282,876. The quantity exported was more than anticipated, being 48,208 kilos., or over 100,000 lbs., but the actual crop did not exceed 36,000 kilos., the surplus consisting of the balance of the crops of 1903 and 1904, which had been held up for better prices. The crop for 1906 will not exceed 20,000 kilos., and there is only a very small stock of old vanilla held locally. The cause of the falling-off in crops for 1904, 1905 and 1906 is the period of drought in 1904, which destroyed one-third of the vines and reduced the vitality of the remainder. The crop of 1904 had been expected, judging from the flowering season of 1903, to be normal, viz., 60,000 kilos., but in consequence of the drought it reached 45,000 kilos. only. The drought of 1904 checked the flowering for 1905, and a crop of 36,000 kilos. was the result. A repetition of the period of drought in 1905 led to an almost complete failure of the flowering season for the crop of 1906, when the total amount cured will not exceed one-third of an average crop, and will be as small as that for 1900, without the saving grace of high prices. Favourable weather in 1906 promises a good flowering season for tho crop of 1907; the vines are in good heart, and it is probable that—as far as a forecast is possible—the crop should be up to 50,000 kilos.

What the failure of the vanilla means to Seychelles may be illustrated by the fact that, for the term of ten years before

1904, the average crop represented an output of 38,476 kilos. valued at Rs. 714,096, and selling at an average price of Rs. 17.95 per kilo. In 1905 the export of vanilla was valued at Rs. 282,876 with an average price of Rs. 5.87 per kilo. And the failure means more than this, for planters were living on a scale commensurate with their recent good fortune, and traders had been accorded credit on a similar scale. Credit ceased suddenly, and advances on crops and on mortgage were called in, and no banking institution existed to help those planters who held valuable properties, but lacked, for the moment, means to keep them in cultivation or to supplement their resources by the introduction of new products. At this juncture the Government, being supported on the authority of the Secretary of State, by a credit with the Crown Agents, was enabled, under the provisions of Ordnance No. 4 of 1904, to advance to approved planters, on the security of first mortgage, sums not to exceed Rs. 100,000 in the aggregate. These loans have saved many planters from bankruptcy, and staved off the abandonment of cultivation on several valuable properties. The amount actually lent at the close of 1905 was Rs. 67,800, when the further operation of the Ordinance had to be suspended. Although the vanilla crop for 1906 is again a failure there has been a resolute effort on all sides to improve coco-nut cultivation, and to develop new industries, especially rubber cultivation; so the prospects for 1907 are more generally hopeful than for three years past.

The quantity of vanilla cleared for London in 1903 was 22,566 kilos., valued at Rs. 137,185, the proportion of the crop and the total value being much as in 1904. London is looked upon as the better market when prices are good, but Paris sales are steadier when demand is dull; that conclusion is based on the fact that there are regular monthly sales in London where parcels are sometimes put up for forced sale; whereas in Paris there is no open market, but the principal buyers, having standing contracts with the wholesale consumers, are ready to buy at a figure which is not subject to market fluctuations. As the price ruled uniformly low during 1905, the proportion sent to London was no more than 46 per cent. of the total; in prosperous years the proportion sent to London has been as high as two-thirds; the exports of vanilla to Paris included more than half the crop (24,757 kilos.) valued at Rs. 136,462.

The Report by the Curator of the Botanic Station for the year 1905 states that the rainfall during 1905 was unfortunately distributed and the vanilla crop for 1906 will be considerably reduced. The weather was very promising until the end of July, but the rain fell abundantly in August and September, and the vanilla vines put forth new growth instead of flowering. Orange and lime trees should be planted on a much greater scale than they are at present for exportation as fruits, and for the production of citrate of lime. In short the climate of Seychelles is highly beneficial to the growth of citrus trees, and better attention should be paid to them. Citrate of lime is imported into the United Kingdom to the amount of 1,400 tons annually, and a Seychelles planter has succeeded in making a sample of citrate containing 65 per cent. citric acid. The lime industries are specially adapted to Seychelles labour and to the shipping difficulties of the Colony, and there is also a certain amount of profit to be derived from them by the production of hand-press oils (worth 3s. 6d. on the London market). The future of this Colony lies in tree-planting on a greater scale than it is at present, and not in cultivating herbaceous plants which are so susceptible to climatic variations.

Owing to the fall in the price of vanilla, the Curator was asked to prepare an extract from inferior vanilla in order to try to avoid exporting low-grade beans as such. The experiments are not yet completed, and the extracts will soon be forwarded to the Imperial Institute for valuation. A simple maceration of 400 grammes of vanilla in four litres of alcohol is not sufficient, and the *modus operandi* which has given the best results, is the following :—The vases containing vanilla arranged in the form of a battery and alcohol at 80° to 85° allowed to remain one week in one vase before being transferred to the next containing fresh vanilla. A sort of diffusion is then practised until the four or six vases have received the alcoholic solution four or six times each.

CURING VANILLA PODS FOR MARKET.*

RIPENING.

Pods grow to their full size in five or six weeks, but take some eight months, more or less, according to the altitude at which they are grown, or the amount of shade over them before they ripen. The indication of ripening is a slight yellowing of the whole pod, which is more marked near its free end. When under too much shade the change in colour is less noticeable, and many pods grown in such places split before they are gathered, and for that reason lose in value. To guard against splitting and yet gather them at perfect ripeness they should be gone over every other day.

HARVESTING.

In removing them from the flower stalks the pods are grasped one by one near their attached ends, very slightly twisted, and at the same time pressed aside with the thumb. They must be taken off quite clean. If a bit of the flower-stalk comes away with a pod, as sometimes will happen, it should be cut off smoothly. Any break or crack in the pod itself, however, near its butt, ranks it as an inferior quality. Buyers are very particular in this respect. After each day's gathering, before the pods are started on their first stage of curing, it is well to sort them roughly into four classes : 1, long ; 2, medium , 3, short, and 4, split.

DIPPING IN HOT WATER

An iron pot or boiler of some kind is necessary in which the water is heated nearly to boiling point—190° F., is recommended.

* Notes chiefly from article by S. J. Galbraith. See *Bulletin of the Botanical Department*, Aug. 1902, page 113.

For a boiler that is 22 inches in diameter by 12 inches deep about 400 of the longest pods are put into a basket, and the whole plunged into the hot water for ten seconds.

After an interval of half a minute dip the pods again into the water, and keep them there for twelve seconds. After another half minute, dip them a third time for fifteen seconds.

Let the water drain off from the pods.

Lot number 2 is similarly treated, and for them the water may be a few degrees cooler, or the dipping times a trifle shortened; and so also with lot No. 3, while No. 4 may be treated as No. 2.

The heat 190° F. is not absolutely essential, but is about as high as it is safe to go; while even the longest pods may be adequately treated in water at 170° F. if they are kept in it long enough. Where small quantities are dealt with less heat is needed.

SWEATING.

After the third dip when most of the water has drained off, the pods are placed in a wooden box or barrel lined with blankets and are closely covered up with the same material.

It is best to have good sized boxes or barrels to sweat the pods in, those holding 2,000 or 3,000 each being preferable, for the more pods there are together the better heat is retained.

The lots (1, 2, 3, and 4) should be kept apart, a fold of blanket being laid on each, if all go into one box.

By the following morning they should have changed to chocolate or puce colour, and are then ready to spread on the drying shelves; but if there is a large number together, and the heat has been well kept in, they may be kept for another twenty-four hours.

DRYING.

Tbe pods are dried by being placed in a single layer between blankets in the sun on wooden trays. The trays should be supported to keep them off the ground.

If sunshine is continuous, the trays are taken it at the hottest part of the day.

A good average heat is 110° F. A few degrees more or less does not matter, but pods are apt to dry too quickly if the heat is much greater. The slower the process the more uniform and better is the result. After some days as they begin to turn soft and show longitudinal wrinkles the pods should only be exposed to the sun at cooler times of the day, so that the temperature is from 90° to 100° F.; and after reaching a certain degree of flexibility (in six to eight days) they should not be put in the sun at all, but kept on the trays in a covered shed at ordinary temperature for about a month. The pods should be turned frequently, so that they dry evenly. If kept too long in the sun, the thin ends of the pods shrink too quickly, and this is to be avoided, although it can not be avoided in the case of inferior, ill-nourished pods. In unsettled weather showers have to be watched for, and the trays carried under shelter till the weather again becomes fair.

When fully cured, the pods are much wrinkled and pliable, bending easily round one's finger. If the contents move easily all along a pod without any unevenness being noticed when it is drawn between the finger and thumb, it is nearly dry enough ; but the right stage can only be learned by experience.

At the moment when it is found that the beans may be twisted easily round the finger without cracking—that is to say, when they have acquired a degree of dryness which can be judged only by experience, a fresh operation is commenced which requires the most minute and vigilant care ; this is termed the smoothing process. The operator must pass every bean between his fingers repeatedly, for, on drying, the beans exude from their entire surface a natural fatty oil. It is to this oil which exudes as the fermentation proceeds, that the lustre and suppleness of the bean is due.

When finished, the pods are well wiped with bits of soft flannel, and then kept in boxes with close fitting lids.

SORTING.

It is better to sort them roughly into lengths as each day's lot is put away and tie up the various sizes in bundles of about 200 each if the numbers allow of it, for they have to be examined once or twice a week in order to remove the mouldy ones and this is much more quickly done with bundles than when they are loose. Moreover, it makes the ultimate accurate measuring easier. Either at this time or later the different qualities are more exactly separated, none but faultless pods, without scar or defect in curing, being allowed in the first quality. The rest rank as seconds, etc. The split pods and the pods that have been cut on account of mould are also kept distinct. It is well to keep a crop at least three or four months before marketing. By that time nearly all shaky pods that are liable to mould will have shown themselves. All are then measured and tied up in neat bundles of fifty pods each of even length, the pods varying in length not more than one-eighth of an inch. In this manner three commercial sorts are obtained, and termed as follows :—

1. "Fine vanilla," 8 to 11 inches long, very dark brown or nearly black, unctuous glossy and clean looking, and finely furrowed in a longitudinal direction. These soon become covered with an abundance of the frost-like efflorescent crystals technically called "givre ;" 2. "Woody vanilla" 6 to 8 inches long, lighter in colour, more or less spotted with grey, not glossy. These are generally the produce of pods gathered in an unripe state. They frost or "givre" very little, if at all ; 3. "Vanillons" of which there are two sorts, these obtained from short but ripe fruit, which are excellent and frost well, and those from abortive and unripe fruit, whose perfume is simply the result of absorption from the fine beans with which they have so long been in contact.

TYING.

The general sightliness of a marketed crop has much influence on the price it will bring, and whatever whims buyers get into their heads the producer must conform to or suffer in pocket. Bundle tying is something of an art, and a deft hand at it is valuable. Sixteen or thereabouts in each 50 are selected for the outside; the rest are tied up as a core, being kept in position with a few turns of the fibre tying cord, while the chosen 16 are carefully placed round them. Great care must be taken that the quality be the same throughout each bundle, as bundles whose core would be found inferior to the outside would be absolutely boycotted by the buyers. The bundle is tied either in three places, near (say one third of an inch from) each end and in the middle, or in two places, an inch or more from the ends, according to the length of the bundle. The core-holding string is pulled out before the final tie is fixed. Any kind of good fine twine may be used for tying. If kept tied some time before being packed the bundles set, as it were, and retain their neat shape.

PACKING.

The finished product, being sorted and tied up into bundles according to the length of the pods, is finally packed into tin boxes of different dimensions according to the length of the bundles; each box containing 10 to 12 pounds.

The usual size measure 12½ to 8½ inches in width, by 4½ inches deep. Each box has a label pasted on it which bears the grower's or shipper's trade-mark. As some chemical action is set up when vanilla rests in contact with tin or iron, thin vegetable parchment paper is placed in the boxes to keep the two apart. The lids are then soldered at the four corners and in the middle at each side, and the tins packed in wooden cases, 6 in each and thus despatched to market.

VALUE.

Messrs. E. A. dePass & Co., writing on 28th, June last, say :—

"The present value of the fine black vanilla varies from 12/6 to 15/ per lb. according to the length while the red variety only fetches 6/ to 10/. These values, although much lower than years ago, must be considered as good. Indeed they are several shillings higher than the prices which ruled 6 months ago but there is no prospect of any serious decline."

The thin parchment paper can be obtained from Messrs. Grimwade & Son, 39 Queen St., Cannon St., London, E.C., in two qualities, viz.. D. Crown Transparent at 4/ per ream, and D. Demy Transparent at 6/ per ream. The latter appears to be the more suitable.

PARA RUBBER: DISTANCE AND INTERPLANTING.*

By HERBERT WRIGHT.

On a previous occasion the subject of distance in planting, in connection with *Hevea brasiliensis*, was discussed, and a certain amount of interest has since been displayed in the subject. It appears necessary, however, to discuss this matter in detail, and to definitely state that I am not in favour of close planting any more than I am in favour of the wide planting of Para rubber trees; any misconception is no doubt due to the brevity of my

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original remarks. In the original discussion the advantages and disadvantages of "close planting and thinning-out" were briefly given, and the pros and cons of other possible systems require to be dealt with.

In the planting of Para rubber there are approximately five systems which may be mentioned:—

1. Close planting—permanent;
2. Close planting and thinning-out;
3. Wide planting—permanent;
4. Wide planting with catch and inter crops;
5. Interplanting with herbaceous and arborescent plants.

WHAT IS CLOSE PLANTING?

To define close planting is a difficult matter, and though actual figures may be quoted, they are subject to modification according to the physical and chemical properties of the soil, and the nature of the climate in which it is proposed to grow the plants. The term—close planting—admittedly implies the planting of the trees at a distance which is not sufficient to allow of the full development of all parts of the plants; the latter is determined by the natural vitality of the plants and the nature of the soil and climate. Medium-distance planting in a poor cabook soil, or in a washed out clay above 2,500 feet in Ceylon, would be regarded as close planting in a rich alluvial soil in the low country of the same island. The trees should be planted at such a distance that they will rapidly develop and take possession of the whole of the soil; their development is controlled by the amount of food which the soil supplies, and it is generally conceded that the better the soil, the more forcing the climate, the greater must be the distance allowed. A typical case is to be seen at the Experiment Station, Peradeniya, where some four-year old trees, all planted 15 feet apart, have overlapped their branches on the flat land, but on the upper part of the hill the spread of the branches is hardly a yard on either side; by the time the latter have taken possession of the soil the former will require considerable thinning out. It has been argued that if the soil is poorer the trees should be planted at wider distances in order to allow a larger area from which the plants can obtain food; this is a contention that loses sight of the necessity of quickly placing the plants in possession of all the soil.

Disregarding the differences in quality of alluvial, cabook, swampy forest, and chena land, from sea-level up to 3,000 feet in Ceylon, and the allowances to be made accordingly, it may be generally stated that on the soil similar to that at Peradeniya, a distance of ten feet apart, or less, for trees of *Hevea brasiliensis*, may be designated as close planting, one of fifteen feet apart as medium distance, and one of twenty feet apart or over as wide planting. These distances are subject to modification according to local conditions, and are here given only to provide a basis for comparison.

The advantages of close planting are that there is a larger number of trees on a given acreage; (2) the ground is better protected with the root and foliar systems, and consequently expenses in weeding are greatly checked, and soil loss thereby reduced ; (3) the rubber can be harvested cheaper ; (4) the cultivation is essentially one of rubber trees which presumably have a higher value than other trees of economic importance, and the method of cultivation over all the soil becomes the same ; (5) the inevitable proportion of poorly developed, stunted, and damaged trees is not as serious ; (6) it is easier to thin out a densely planted estate than to interplant a widely planted one.

The disadvantages are (1) there may be considerable interference in the development of all parts of the plant and the resultant trees be dwarfed and lacking in vitality ; (2) the stems will tend to become thin, long, and spindly, and the thickness of tappable cortex (bark) reduced ; (3) diseases are given a greater certainty of originating and may spread more rapidly because the parts of the plant are nearer to one another or in more frequent contact.

DISTANCE ACCORDING TO SIZE AND AGE.

The cultivation of trees of *Hevea brasiliensis* ranks as unique in so far as it has to deal with a species which grows into a tree of enormous size ; the past and most of the present products, in Ceylon, cannot be compared with the latest arrival, for it overtops the tallest cacao and cinchona trees, and often equals the coco-nut palms, in height and frequently in breadth, age for age.

Trees less than thirty years old, which have never really been cultivated, have a height of 80 to 90 feet and a circumference of 80 to 109 inches ; specimens planted 25 to 30 feet apart have been known to overlap their branches in about 20 years, and fifty years old trees in tropical America even exceed these huge dimensions. This is the outstanding difference between the cultivation of Para rubber trees and all other plants in Ceylon, and though it has been an easy matter in the past, to settle the distance at which tea, cacao, cinchona, &c., should be planted, we are now confronted with a new set of conditions which may require different methods of cultivation.

DISTANCE OF TAPPED TREES.

There is another point which appears to have been overlooked in connection with this subject, and that is the retardation, in growth, which must follow regular paring or tapping. It is no exaggeration to say that most of the old trees in Ceylon were not systematically tapped until the last few years, and but few estates can point to acreages which have been regularly tapped throughout successive years, from the time the old trees attained their minimum tappable size. Whenever cortical tissues are removed or mutilated, the energy of the plant is partly diverted to the production of new tissues in the affected area, for the time being the intimate connection between individual vital structures and that of the latter with cells which have less important functions, is interrupted ; such changes must affect the future development of the plants, especially when of repeated occurrence from the 4th, 5th or 6th years onwards. In the absence of any measurable effects following the tapping of trees, one can only generalise and state that the sizes of trees so treated will probably be less than those of specimens which have never had their bark so excised and otherwise mutilated. Time will certainly prove the wisdom or error of planting Para rubber trees ten to fifteen feet apart, as most estates in Ceylon appear to be so planted. Systematic paring away of the bark of rubber trees will as assuredly change the habit and ultimate dimensions of the mature trees, as has the contsant plucking of the leaves of tea plants, and the peeling of the cinchona bark.

ORIGINAL AND PERMANENT DISTANCE.

It is taken for granted that the reader is familiar with the sizes of Para rubber plants from their first to their thirtieth year in different soils and climates; the question to discuss is whether the original should be the permanent distance. No one who has seen the uncultivated thirty-year-old trees at Henaratgoda can doubt that such specimens require at the very least, a distance of thirty to forty feet, if they are to be allowed to continue in their growth and maintain a healthy constitution; what the required distance will be when they are 40 to 50 years old it would be unwise to predict. In striking contrast to this are the thin, tall stems of two to four year old trees, and the poor lateral spread of the foliage when they have just reached the tappable size. Between the first year of tapping and that represented by the old Henaratgoda trees, is a gap of 25 years--probably the equivalent of a longer period when the newly-bearing trees are regularly tapped, year in and year out. I am of the opinion—though I may be wrong—that it is absolute folly to plant, in a clearing, Para rubber trees alone, at a distance which they will require when thirty years old; we are dealing with a species which does not, like cocoa and similar plants, attain the greater part of its maximum size in the first six or seven years, but with one which continues to grow, year by year, and even when thirty years old, still keeps on growing and throwing its roots into new soil. Though Para rubber trees continue to grow in this manner, though the ultimate size to which they will attain can only be roughly guessed at from our scanty knowledge and experience, yet we know that when their stems are only 20 inches in circumference they yield marketable rubber in very satisfactory quantities. Four to six years is a long time to wait for the first returns, and from a commercial standpoint the distance at which trees can be planted, without entailing undue interference in general development, and brought into bearing in their fourth year upwards is the one to be decided. Of course when trees are widely planted they come into bearing as early as when closely planted but there is no very great difference in dimensions of trees planted at widely different distances up to their fourth year; the growth in the first four years is not as conspicuous as in later years, and even in the richest soils there is a limit, notwithstanding statements to the contrary, to the root and foliar development of Para rubber plants just as there is to parts of other cultivated plants.

The closer the trees are planted, within reasonable limits, the greater is the yield per acre, in the first tapping year, a consideration not to be lost sight of in view of the wavering in the price paid for the raw rubber during the last ten years ; in fact it is the condition of the present market as compared to that of past years, wherein lies the main wish to possess a large number of trees of a tappable size as early as possible. It should be remembered that one tree which will give 1lb. of rubber per year, now, is about equal to the value of one double its size which yielded 2lb. of rubber in 1894 ; no one can dispute the desirability of placing produce on the market while the price is high.

If the principle here outlined, of allowing a definite area of soil according to the size and age of the tree is granted as being reasonable, our next point is to discuss how the distance can, with advantage, be gradually increased. It is obvious that an increased root area can only be given by the destruction or removal of trees already existing, a conclusion which brings forward the methods of procedure possible or advisable, when a Para rubber property is interplanted with trees of its own kind or with those of cocoa, coffee, camphor, tea, Erythrinas and Albizzias, &c.

CLOSE PLANTING AND THINNING OUT.

The possibility and method of thinning out rubber trees on a closely-planted estate was discussed in my original paper. The great outstanding advantage of this system is that a return is obtained by tapping only intermediate trees, and can be carried out with the definite idea of extracting every possible particle of rubber from such trees, and finally felling them and uprooting the stumps. But, as I have previously pointed out, it can *only* be recommended on the understanding that the estates will be thinned out after the fourth or fifth year and all root stumps extracted. The practicability of extracting rubber, valued at over 5s. per lb., from trees having a circumference of 18 to 20 inches—that is in their 4th or 5th year—has been proved long ago, and is taking place to-day on some very prominent and valuable estates ; it is difficult to understand the reason for any statement to the contrary, in spite of what has and is still being done.

An alternative method of obtaining rubber from such trees—by felling them and macerating the bark—has been suggested. At the present time this cannot be recommended, first because the yields thus obtained have been less than when the trees have been tapped standing ; and, secondly, because the rubber obtained by maceration appears to suffer in quality owing to its being mixed with the sap of the cortical cells ; nevertheless, we know that rubber is thus obtained from other plants, and the results obtained justify further investigation.

The objections which have been raised against thinning-out are briefly that (1) planters are not keen to thin out, fell and uproot the plants, (2) it is a very difficult matter to kill a Para rubber tree by tapping, (3) there may be interference in the growth of the remaining plants, (4) diseases may be encouraged to flourish on the weak trees which are not removed.

It is admitted that by some systems of tapping it is very difficult to kill a Para rubber tree within a couple of years, but from observations made on trees which have been rapidly tapped on the paring and spiral system, very little doubt exists in my mind as to the results obtainable. On such trees the spiral system can be adopted, and at the end of twelve months the tree should be removed and the stumps extracted. The unwillingness of the planters to actually fell the trees so tapped is said to be encouraged by results obtained on some estates, where it is reputed that the total yield, per acre, appears to be approximately the same, no matter whether the trees are distanced ten or twenty feet apart; I have never seen any figures or authoritative reports which prove this.

The interference in growth, in trees originally planted ten feet apart, will vary with the soil, climatic, and other conditions; but in the case of unpruned Para rubber trees at Peradeniya, and others in relatively poor soils in the low-country of Ceylon, I have previously explained that there is no very serious interference in either root or foliar development up to the period specified. Occasional branches and roots will overlap, but not to any great extent except under very good conditions; the exhaustion of the surface soil may be partly balanced by the application of manures. If, however, the estate is not thinned out, considerable interruption in the radial growth of stem and root structures will undoubtedly occur, and it remains to be proved whether the trees on such a property make up in number what they lack in size.

The liability of weak and close-planted trees to the attacks of fungi and insects has been raised as an objection against this system; the liability of the bark, exhausted of late, to insect pests applies to that on any tapped tree, but in neither case would it be possible to completely extract the latex from such tissues except by killing them, a procedure not yet recommended. The liability to root rot would be largely overcome by extracting the stumps, as is recommended on the clearing itself; on the Yatipawa plantation where the roots of felled rubber trees were allowed to remain in the soil and decay, the remaining trees have recently been described as healthy; perhaps this apparent immunity can be associated with the age of the felled and remaining trees, or with the difficulty with which the root-rot fungus actually commences on Para rubber stumps. On most estates the root fungus is transmitted from the roots of trees other than rubber, which ramify in the soil and reach the rubber roots no matter how widely the latter may be planted. It has been questioned, in view of the fact that the roots of jak and cotton trees, etc., traverse a greater distance than that between any two rubber plants as at present planted, whether the difference in distance between Para rubber trees planted ten and fifteen or twenty feet apart appreciably affects the spread or distribution of the root fungus. It cannot be doubted that the closer the roots the greater is their liability to catch whatever fungus is in the soil, but as against such a disadvantage has to be set the advantage of the produce obtained even allowing that the roots are not removed but left to decay.

If it can be proved that the excessive tapping of intermediate trees and the removal of their root stumps is calculated to aid in the spread of diseases, then the system here outlined must not be in any way encouraged, but until such has been established the system deserves consideration. As matters stand at present, where most of the rubber has been closely planted, it will be necessary to adopt some process of thinning-out, if the Para rubber trees are to receive the soil and light which their gradually increasing size will demand.

PERMANENT WIDE PLANTING.

The third possible system is that of permanent wide planting, by which is meant that no thinning-out or intercrops of any kind shall be entertained and the trees be planted at a distance sufficient to last for the whole of their lives; assuming that such trees will be tapped from the time they are 20 inches in circumference, a distance of twenty feet or over may perhaps be designated as wide planting. A distance of twenty feet apart may not appear to be a very wide one, but it is taken as the minimum in the system under discussion, it may be completely covered by the roots and foliage of untapped trees when 20 years old, but we have no evidence of the demand which regularly tapped trees of such an age will make.

Briefly stated the advantages of permanent wide planting are that the trees are never interrupted in their growth; they attain the maximum size in the minimum period of time; thicker, shorter and better yielding trees are obtained; collecting and other operations are simplified; diseases will probably not spread as rapidly and can be more easily controlled. The disadvantages associated with wide planting are that there is a deplorable waste of soil until the ground is covered; there is a serious reduction in the available tapping area during the first ten or fifteen years the fewness of the trees enhances the loss occasioned by the death of a single tree; and interplanting of such a property can only with difficulty be carried out.

The interruption in growth among closely-planted Para rubber trees is one of the greatest disadvantages attendant on close-planting, and the freedom from such of first importance when the trees are more widely planted. But to argue that trees because they are more widely planted will attain the maximum size in the minimum period is apt to be misconstrued into meaning that the trees always grow more vigorously and at a quicker rate; it should be clearly understood that there is an average incremental rate of growth above which most Para rubber trees do not develop, and a maximum annual average increase of five to six inches in stem circumference is indicated by trees of varying age and planted at widely different distances. The largest thirty-year-old tree at Henaratgoda, neglected and grown on poor soil, has a circumference of only 109½ inches, and the average of such trees, planted at relatively wide distances does not exceed 75 inches—an incremental circumferential growth of 2½ to 3 3-5ths per year for each of thirty years. No one for a moment can doubt that, within limits, the fewer the trees the better they can develop and the greater is the tendency to produce short, thick trees ; but the supplying of areas of soil beyond the reach of the best developed roots during the first ten years' growth will not necessarily be accompanied by a much increased rate of growth during that time ; there appears to be an average incremental rate of growth for parts of plants, often of specific importance, and beyond which it is often undesirable or impossible to go. Trees which are widely planted do not appear to reach the tappable size—20 to 24 inches at a yard from the ground—much quicker than those planted ten or twelve feet apart : subsequently the wider planted trees increase in circumference quicker than the closely-planted ones, other conditions being the same.

YIELD PER TREE AND PER ACRE.

The better developed the tree the larger is the yield of rubber obtainable and the better able is the plant to stand the effect of tapping operations.

The differences in yield obtainable from an acre of 100 trees planted 20 x 20 feet and one of 190 planted 15′ x 15′, or 430 planted 10′ x 10′ have not yet been demonstrated ; closely planted areas during the first few years would probably give more rubber *acre for acre*, than those widely planted, but as time went on the average yield, per tree, would increase on the widely planted area with the more continuous increase in circumference.

The differences in total yield per acre, of 430, 190, and 100 trees in the 12th or 20th year are not known, but there are reasons for imagining that the intermediate number would give satisfactory results at such periods ; if the total yield per acre, is, as has been stated, approximately the same, no matter what the differences in distance is, it means that if the widely planted trees give each 2 lb., of rubber each, per year, those on the other estates must give approximately 1 and 0·46 lb. respectively.

It is generally believed that the great advantage of permanent wide planting over permanent close-planting lies in the check given to the spread of diseases and the better control which the planter has over them. This is, however, in a great measure only temporary, for, once the roots have met and the branches come into contact, the conditions are more nearly equalised. It may even be disputed whether the differences in distance between widely and closely planted trees of Para rubber is an effective check against the spread of many diseases, especially where leaf pests are concerned. Distance does not give immunity from attack on an ordinary rubber estate ; the differences under discussion are trivial when one considers how spores and insect pests may travel.

STERILIZATION OF SOIL.

No one who has worked with the Ceylon soils will dispute the fact that exposure of the surface soil to the sun and rain, for a period of several years, results in a great loss. The soluble constituents are carried away in the drainage water, the organic matter is reduced in quantity, the ground becomes hard and caked and the destruction of useful bacteria assured. The loss occasioned in tea clearings, where the plants are planted three to four feet apart, or on cocoa estates where cocoa saplings, distanced nine to twelve feet apart, are interplanted with Erythrinas and Albizzias, has been considerable ; but in the wide planting of rubber trees alone, a much larger proportion of the soil is exposed for many more years, and the loss of food constituents and sterilization of the soil become much more serious matters. This constitutes a very serious disadvantage against permanent wide planting of Para rubber trees. The reduction in available tapping area consequent on the fewer number of trees on widely planted estates is an objection of importance in the early tapping years, and the fewness of the trees would ensure that the death of a single tree would be occasioned with relatively more serious loss.

WIDE PLANTING AND INTER CROPS.

The fourth method is that of permanent wide planting, and interplanting with more or less temporary intercrops. The advantages of this system are many, as Para rubber trees can for several years be more or less successfully grown in association with cocoa, coffee, tea, camphor, &c., when widely planted. Such a system provides against a slump in rubber, however unlikely such may be, and is usually recommended because the admixture of trees of entirely different characters serve to check the spread of diseases ; the latter has been often disputed since stumps of roots of such intercrops may be left in the soil a few years. Another advantage lies in the fact that the soil is more quickly covered, the roots of the various plants assist in the disintegration of the soil, and the total loss is, therefore, not as great as when rubber trees alone are planted ; this again is open to the objection that the cultivation of the intercrops, does in the removal of woody, leaf and fruit tissues, lead to considerable exhaustion. A very noticeable feature on all Para rubber estates thus interplanted is the check given to the growth of the weeds, and this apart from the fact that some return is obtained at an early date, weighs seriously with many planters. It has been estimated that the weeding on a rubber estate of only 300 acres, necessary to bring the trees into bearing, is no less than Rs. 25,000,—a considerable item, especially where large acreages have to be dealt with.

But what appeals most strongly to the opponents of close-planting is the fact that by this system the Para rubber trees can be originally planted out at a distance which will allow of permanent and undisturbed occupation by the rubber trees ; as the trees increase in size, the intercrops and not the rubber trees can be thinned out.

DISADVANTAGES.

Though the system of widely planting rubber trees and interplanting with other products has much to recommend it, and appeals to those with limited capital or those who desire to adopt a system intermediate between permanent close, and wide planting, it has many disadvantages. First and foremost must come the objection that the introduction of any intercrop divides not only the attention of the superintendent and coolies, but also the demand on the soil ; people generally wish to plant rubber and nothing else, they do not care to be troubled with anything but rubber trees, and they are prepared to wait for their returns from such a cultivation. It cannot be doubted that there is something in these contentions.

What are the results which have been obtained with intercrops in widely planted rubber? Probably the most successful combination we know of at the present time is Cocoa and Rubber, though tea and coffee deserve consideration. An estate planted with rubber 20 x 20 feet and cacao 20 x 20 feet, possesses approximately 100 trees, per acre, of each kind. The interplanted cacao trees will probably give $\frac{3}{4}$ to 1lb. of dried cacao each during the fifth or sixth year, which, valued at an average price of about 60s. per cwt. means that each tree only gives, in gross returns, about $4\frac{1}{2}$d. to $6\frac{1}{4}$d. of produce per year ; each rubber tree may, at present prices, be expected to yield about 4 to 5 shillings worth of produce at the same period. The fact that approximately ten cacao trees will be required to produce the equivalent of a single rubber tree, leads one to question whether it is financially sound to give up such a large area of soil to such an intercrop, and many have decided, on this ground alone, to plant their rubber trees closer and elimate all intercrops.

The occupation of such a large proportion of the soil by intercrops among the rubber, must lead to a certain amount of interference in root development of the rubber trees, and partial soil exhaustion may be expected. Furthermore, such intercrops are usually only transitionary, they do not last for very many years, though the original expenditure in planting them is much the same as when the intercrop is planted alone ; cocoa appears to be an exception to a certain extent, as it lasts for many years under widely planted rubber, if properly attended to.

INTERPLANTING WITH HERBACEOUS AND ARBORESCENT SPECIES

Lastly we are left to consider the interplanting of rubber estates, no matter what distance the rubber plants are from one another, with species which are of value for shading, manuring, and other purposes.

The broad casting of seeds of Crotalaria striata, Vigna species, or interplanting the rubber trees with plants of Albizzia moluccana, or cuttings or plants of Erythrina species (Dadaps) has been frequently recommended for experiment. It is obvious that such a system checks, to some extent, the loss of soil ingredients, the ground is shaded during the various seasons, a more uniform condition of soil temperature and moisture is maintained, the weeds are kept in check, the roots of the plants break up the soil, and a large amount of organic matter is available for manuring the rubber plants. On the other hand, it can be argued that the interplanting of such species often interferes with the growth of the roots of the rubber plants, the dense growth harbours porcupines, hares, pigs, and other rubber pests, large stumps of trees are left in the soil, and their cultivation occasions additional expense and reduces the labour force available for rubber work.

This part of the subject has been so fully dealt with on previous occasions, that it need not be further dilated upon.

RECAPITULATION.

It should now be clear that a single perfect system has not yet been devised. There are, of the five systems here enumerated, two which it is difficult to believe in, namely, permanent close planting and permanent wide planting: the former appears to me to be wrong in principle and the latter extremely wasteful. I am more in favour of those systems, which, though faulty in many ways allow of the rubber trees being provided with increased root area as they advance in age and increase in size, this to be done by the thinning-out of rubber trees, intercrops, and other plants, and the uprooting of the stumps of trees so treated.

BASTARD LOGWOOD FROM JAMAICA.*

By E. DRABBLE, D. Sc., F.L.S., and M. NIERENSTEIN, Ph. D.

Hæmatoxylon campechianum, L., the tree producing the dyestuff termed logwood has several forms differing in the colour of the wood and the amount of dye present. These different forms generally grow side by side, and are apparently not the result of any difference in external conditions, such as soil or climate. Neither do they appear to be the result of difference in age or vigour. The suggestion that disease may be responsible for some of the forms is not supported by Grunberg and Gies (Bull. Dept. Agric. Jamaica, vol. ii., 1904), and indeed the ordinary Logwood tree is often attacked by root rot—a fungus disease—without, according to statements from Jamaica, changing the character of the dye materially. It is generally concluded that there are several varieties of *Hæmatoxylon campechianum*, differing in amount of dye present, and in the colour of the wood. These differences are probably associated with differences in metabolism, affecting the formation of the dye. In Jamaica three varieties are recognised, and in Honduras four. In addition to the common, true or red logwood, which is by far the most abundant form, is found a tree with deep blue wood, which when chipped develops a rich deep bronze colour. Another variety, although of chocolate colour, yields only about one half the per centage of dye. Pale pink and yellow forms lead on to a white-wooded tree, from which no colouring matter can be obtained. These forms with a small quantity of dye, or no dye at all, are termed "bastard logwoods," or "mulatto logwoods." Some of them have been stated to yield a pale yellow-green dye, which, when mixed with hæmatoxylin, reduces the staining power of the liquid.

It is said that even the dark form of bastard logwood fades in colour with age and exposure, and even when soaked for some time it yields but little dye.

Earle (J. of N. York Bot. Garden. iv. 3, 1903) finds no constant

*Quarterly Journal Inst. Com. Research, Liverpool.

difference in the leaf and trunk. He finds the red logwood to be variable in form, colour, and texture of leaf, time of floweriug, form and extent of ribs on the trunk, colour of bark, &c., and specific dye-producing qualities of the heart wood.

Grunberg and Gies (Bull. Dept. Agric. Jamaica, vol. ii. 1904) finds that the seedlings of the two are indistinguishable, and an analysis at twelve months indicated no difference.

ANATOMY.

The structure of the wood in the specimen submitted agrees very closely with that of the true logwood, The vessels are large and well developed, and the texture of the wood is slightly more open than in true logwood. Associated with this is the rather lower specific gravity of the specimen under examination—1.01. The vessels generally occur singly, rarely in groups of two or three. Associated with the vessels are tracheids, and strands of long pointed fibres, together with some parenchyma, some of the cells of which contain crystals of calcium oxalate. Extending across the wood between the medullary rays are bands of small elements with dark contents. These bands alternate tangentially with bands of tracheids and vessels. The medullary rays are narrow, from one to three cells in width.

A feature of considerable interest in the specimen received, is the occurrence of fungal hyphæ in the lumina of the vessels, tracheids and medullary cells. In some parts of the wood these hyphæ are present in very great abundance. In other parts they could not be detected.

The presence of the fungal hyphæ is suggestive,since the living fungus might reduce the dye with the formation of a colourless compound. We do not suggest that the absence of colour is due to the attack of the fungus. Many specimens of bastard logwood must be examined before a decision can be given one way or the other, but the presence of the fungus is worth noting.

It has been pointed out previously that there was a possibility that the bastard logwood of Jamaica might contain tannins, and find on that account a commercial use. (Quarterly Journ. Inst. Com. Research, No. 2, p. 70.)

An investigation from this standpoint has been made. The saw-dust of the heart-wood used for analysis was found to contain :—

Water ...	9·72	per cent.
Tannin ...	6·34	„
Organic (non-tannins)	2·80	„
Inorganic (non-tannins)	1·70	„
Insol. in water at 100° C.	79·44	„
	100·00	

The dry wood was also examined and was found to contain :—

Raw Fibres (Henneberg & Weender method)	50·67	per cent.
Ash	2·52	„
Soluble in alkali and acid	46·81	„
	100·00	

A qualitative examination of the extract gave the following results :--

With gelatine	precipitate
Ferric Chloride	bluish green
Bromine water	no ppt.
Formaldehyde and Hydrochloric Acid	ppt.

The extract was also concentrated (100 cc. to 10 cc.) and gave with alcohol no precipitate, indicating the absence of "phlobaphenes." Hence the tannin from bastard logwood would be valuable for the manufacture of book-binding leather where the "phlobaphenes" are the cause of the so-called "rot." The wood gives a striking red colour with phloroglucinol. Attempts to isolate vanellin or citrol failed, and the phloroglucinol reaction is probably due to the presence of hadromol.

With regard to the per centage of tannin found in the bastard logwood, this ranges from 6.34 to 6.69 per cent. Oakwood with from 5 to 8 per cent. and chestnut with from 7 to 8 per cent. tannin are both of commercial value, and taking into account the freedom from "phlobaphenes" the bastard logwood should prove of commercial value as a tannin material.

BOARD OF AGRICULTURE.

EXTRACTS FROM PROCEEDINGS.

The usual monthly meeting of the Board of Agriculture was held at Headquarter House on 14th August : present—the Director of Public Gardens and Plantations, the Chemist, the Superintending Inspector of Schools, Mr. G. D. Murray and the Secretary, John Barclay.

The chairman, the Hon. H. C. Bourne, Colonial Secretary, intimated that the Governor having fixed a meeting of the Loan Board at the same hour, he could not be present, and the Archbishop wrote expressing regret that another important engagement prevented him from being present. The Director of Public Gardens acted as chairman.

Arrowroot—The Secretary made reports as follows :— With regard to the arrowroot for the Public Institutions,—as instructed he had an interview with the Superintending Medical Officer who agreed to stock Jamaica arrowroot in the Medical Stores and issue it along with the usual medical supplies. The Secretary would arrange to supply it in barrels beginning next March for the new financial year, and the average price would not be more than what the institutions were paying at present.

Cotton Industry—Mr. Briscoe had arranged an intinerary to visit all intending cotton planters within the Liguanea Plains. Two hundred acres of cotton would probably be put in. Mr. Desporte's land, to the extent of 50 acres, was ready for planting whenever rains fell.

Drought in St. Elizabeth—As regards the drought in St. Elizabeth, the Secretary had brought the matter before the Agricultural

Society and the Board of Management had voted £10 for a supply of seeds such as corn, beans and peas, and potato slips to help the people to plant food-stuffs whenever rains came. The Secretary had made arrangements for centres of distribution and notice to be sent him from various points whenever sufficient rains fell for planting purposes. As this money, however, had not gone very far, he had asked the "Gleaner" for £10 from their fund.

Instructors—In connection with what was said in the Minutes regarding Instructors, the Secretary read letter from Mr. Cradwick which showed that the arrangements for the defining of the boundaries to suit travelling arrangements and for the Instructors meeting with each other in connection with certain Branch Societies, were now complete and agreeable to the various Instructors.

The following reports from the Chemist were submitted:—

1. Proposal to establish Jamaica Rat Virus Service.
2. Selection of Distillers to attend special Course.
3. Syllabus of Distillers Course.
4. Publication of Report on experiments by the Sugar Experiment Station for 1906-7.

1. The Secretary was instructed to write the Government that the Board recommended that the Rat Virus Service be authorised, the preliminary expenses to be met from the vote for the ordinary services of the Laboratory.

No. 3 was directed to be circulated and Nos. 2 and 4 were approved of.

The Director of Public Gardens and Plantations presented reports as follows:—

1. Instructors—Reports and Itineraries.
2. Hope Experiment Station.
3. Letters from Mr. Cradwick.

1. Stating that Mr. John Lockett in the Agricultural Journal for January, February and March, 1907, had drawn attention to the fact that some of his cocoa trees were, in his opinion, killed by Fiddler grubs, and these grubs killed trees that were the finest of a fine group: and in the Journal for April, 1907, Mr. H. C. Bennett had written an article confirming Mr. Lockett's opinion. Mr. Cradwick said that for the last three months he had carefully investigated the matter and after visiting Mr. Lockett's plantation and examining dead and dying trees which Mr. Lockett was of opinion had been killed wholly and solely by the Fiddler Grubs he remained still more strongly of opinion that these grubs and other similar grubs did not attack the roots of healthy trees but only such trees as had been injured and were unhealthy through growing under wroug conditions.

The Chemist said that he was of opinion that the grubs attacked perfectly healthy trees in certain soil.

This report was directed to be circulated.

2. Mr. Cradwick asked that he might get supplies of cane tops of the new seedling varieties for distribution in the district of Saint Mary and Portland where the settlers grew cane for sugar making.

The Secretary was instructed to ask him to communicate with the Chemist on the subject.

The following papers which had been circulated were now submitted for final consideration :—

1. Letters from Mr. Cradwick re Cocoa & Gunjah with remarks from members.

2. Mr. Briscoe's report for June of visit in St. Andrew and St. Thomas-in-the-East and noting the resuscitation of the Bath Agricultural Society.

Mr. Cradwick's report on visits in St. Mary during June stating that during that month there had been a great scarcity of water in that parish, that vegetation looked fair while the cocoa looked particularly well, stock was suffering, and in some places human beings from want of water ; and that the entries for Small Holdings Competition in St. Mary were very promising, there being about 60 to date.

3. Mr. Cradwick's revised itinerary for August through being withdrawn from St. Catherine, and for September.

Vanilla—The Director of Public Gardens and Plantations stated that while he was in England he had an interview with Messrs. E. A. DePass & Co. on the subject of Vanilla and begged to submit a letter from that Firm giving full information as to market prices, prospects, and the manner in which the Vanilla should be put up. He submitted a sample bundle of the best Vanilla and a sample tin box in which the bundles of Vanilla should be packed, also a specimen of the parchment with which it should be lined. He stated that he would publish these particulars in the next Bulletin.

The usual monthly meeting of the Board of Agriculture was held at Headquarter House on 11th September, 1907 : present :— Hon. H. Clarence Bourne, Chairman, the Director of Public Gardens, the Chemist, Messrs. G. D. Murray, Conrad Watson, and the Secretary John Barclay.

The Secretary read a report on the efforts to establish the cotton industry, giving details regarding the imported St. Vincent Sea Island Cotton Seed which had been supplied to Mr. Desporte and had not grown well. After discussion he was instructed to send a sample of the seed to the Island Chemist to be examined and analysed. The Secretary also reported on his visit to Saint Elizabeth.

Rat Virus—The Secretary read letter from the Colonial Secretary's Office in reply to his letter sending in recommendation of theBoard on the Chemist's proposal to establish a Rat Virus service, stating that if it was the intention of the chemist to institute pathological experiments on living animals in the Government Laboratory, His Excellency was unable to approve of the proposal. The Secretary said he had submitted the letter to Mr. Cousins who had returned it with a memorandum explaining his intentions, and he was directed to re-submit the letter with the memorandum to the Governor.

School Gardens--The Secretary submitted a Memo. concerning some matters that had come to his notice in connexion with School Gardens in Manchester and St. Elizabeth, and he was directed to circulate this for the comments of the members.

Vanilla--The Secretary said that as regard the arrangement for giving instruction in curing Vanilla pods in Hanover, Westmoreland and St. Elizabeth, he had been unable to find that Vanilla was growing in Hanover and Westmoreland as stated by Mr. Ventresse, so that practically the instruction would be confined to northern St. Elizabeth. He said that Mr. Palache and himself had found people there much interested in Vanilla and were extending their planting cautiously. He hoped to submit an itinerary from the Rev. Mr. Maxwell at the next meeting.

Resignation of Mr. Fursdon--The Secretary submitted a latter from Mr. Fursdon stating that as he would not have any time to attend the Board Meetings, he would ask the Chairman to accept his resignation. As Mr. Fursdon was the representative nominated by the Agricultural Society, the Secretary was asked to inform the Agricultural Society of Mr. Fursdon's resignation and ask them to nominate to His Excellency the Governor, another representative.

Chemist's Reports--The following reports from the Chemist were submitted :--

1. Distillers' Course for 1907.
2. Experiments in getting rubber from the Milk Withe in Upper Clarendon, asking to be authorised to transfer £10 from his travelling allowance for the purpose or carrying through the experiments.

No. 1 was directed to be circulated.

No. 2 was directed to be forwarded to the Government with a recommendation that the amount be authorised.

Reports from Director Public Gardens--The following reports from the Director of Public Gardens were submitted :--

1. Mr. Cradwick's report for August: Mr. Briscoe's Itinerary for October.
2. Hope Experiment Station.
3. Application from Mr. Briscoe asking for certain tools to carry through his work as Instructor. This was passed.
4. Letter from Mr. Cradwick *re* request for his service to advise on cocoa in St. Catherine.

The Secretary was directed to advise him that he had already been authorised to visit St. Catherine in cocoa interests in October and he could include this special visit.

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EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.,

Director of Public Gardens and Plantations.

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RUBBER PLANTING IN MEXICO AND CENTRAL AMERICA.

By PEHR OLSSON-SEFFER, Ph. D.*

Director La Zacualpa Botanical Station and Rubber Laboratory, Mexico.

INTRODUCTION.

Very litttle has been said or published so far about rubber planting in Mexico and Central America. So little, in fact, that people generally do not seem to know that anything is done in those countries as regards rubber, except a few erratic attempts at cultivating that much despised *Castilla* rubber tree. A short time ago I met a Ceylon planter in Japan. When our conversation turned towards rubber and I had received many tales about Ceylon, I volunteered the information that we had one or two plantations also in Mexico. He was highly surprised.

A desire to dispel some similar views, which I have found in Singapore, has tempted me to publish this article, which partly consists of some advance sheets from my small handbook, "Cultivation of the *Castilla* Rubber Tree," now in the printer's hands, and partly of data obtained from my first Annual Report from La Zacualpa Botanical Station and Rubber Laboratory, which is soon to go to press. I have added some reflections which will perhaps give this article a rather pronounced tendency, and I have advanced some ideas which all of the Mexican planters are not yet ready to entertain.

THE NAME "CASTILLA."

I wish first to explain why I am persistently using the generic name *Castilla*, instead of *Castilloa*, to which most persons are accustomed. I go on the principle that everything should be

* From Agricultural Bulletin of the Straits and F. Malay States, VI. 1., Jan. 1907.

called by its true name. The right name of the Central American rubber tree is *Castilla*. It was first described and named by the botanist *Cervantes* in 1794, and the description was printed the same year in "Supplemento à la Gaceta de Literatura." It is here written *Castilla*, and the tree was named thus in honour of the Spanish botanist *Castillo*, who had died the previous year, while he was working on a flora of Mexico. In 1805 an English translation of the paper was published anonymously, and now the name was changed to *Castilloa*. The translator (who is believed to have been CHARLES KOENIG, the keeper of the mineralogical department of the British Museum) had no right to alter the name. A Mexican botanist had already, with just as little right, proposed to change the name to *Castella*, shortly after the plant had been described. Now we have in systematic botany certain recognized rules of nomenclature, and one of these is that of priority. As *Castilla* was the first name given, it should remain so. This question was discussed and settled in 1903 by O. F. COOK, in "The Culture of the Central American Rubber Tree" or Bulletin No. 49, Bureau of Plant Industry, United States Department of Agriculture, but it seems to have been overlooked.

DIFFERENT FORMS OF CASTILLA.

Another question which is causing considerable misconception as regards our Central American rubber tree is that of species. *Castilla elastica* Cerv. in a very wide species, containing numerous forms. A species-making botanist could easily divide it into a dozen species or more. I have personally observed nine fairly distinct forms, but I still hesitate to recognize them as good varieties. KOSCHNY, a Costa Rican planter, who has written considerably in "Der Tropenpflanzer" about *Castilla* in certain parts of Central America, speaks of several "species," but does not give satisfactory descriptions that would warrant his forms to receive the distinctions of species. COOK described the form occurring on and near La Zacualpa rubber plantation in Soconusco, Mexico, as a new species, *C. lactiflua*. In Hawaii I saw a form planted from seeds obtained from a seed merchant in Paris under the name var. *nicaraguensis*. It certainly was different from any other form I have seen elsewhere. *C. markhamiana* is generally considered to be a separate species, and the *Castilla* grown in Ceylon is sometimes referred to as this species. Certain is it that the Ceylon *Castilla* is not identical with any Mexican *Castilla* that has come under my notice.

From the planter's point of view it is of little significance whether one or more species are cultivated so long as the rubber is obtained. But it is in this fact of the existence of many different forms in which we have to find an explanation of the reputed failure of *Castilla* in different places, where its success had been presupposed.

If we plant seeds of the *Castilla* of the Atlantic side of Southern Mexico, with an almost continuous rainfall, on the Pacific slope of the Sierra Madre, where we have a distinct dry season of six months, the tree does not succeed in growth, the amount of latex is smaller, and a planter would soon find out that he had made a great mistake, had he tried this experiment on a large scale. It seems to me probable that if attention had been paid to this circumstance, *Castilla* would be more of a favourite than it is.

We are working on this problem at La Zacualpa Botanical Station. Herbarium specimens are secured of *Castillas* from various parts of Central America, and seeds of different varieties are being planted in the experimental plots. In due time we expect to be able to throw some light on this question. Seeds of our local *Castilla lactiflua* have been sent to various places in the West Indies, to British Guiana, Gold Coast and other places in West Afriea, Ceylon, Java, Queensland, Philippines and Hawaii, and I expect to obtain reports upon the progress and development of the plant under the different conditions prevailing in these different countries.

THE GEOGRAPHICAL DISTRIBUTION OF CASTILLA.

Castilla grows wild from 21° north latitude in Mexico southward through Guatemala, Honduras, San Salvador, Costa Rica, Nicaragua, Panama, and also in North-Western South America. The area in Mexico is a belt ranging from ten to one hundred miles in width and extending from the port of Tuxpan in the north to the western boundary of Campeche, a distance of about 500 miles. The extent of the rubber belt is also rather small in Central America, where it can be said to follow the Cordilleras on both sides, while in South America it grows on the western slope of the Andes of Ecuador and Peru.

Castilla rubber is generally known in the market as "Centrals" but it derives many other names from the countries and localities in which it is found growing. Thus it is called Peruvian caucho, Guayaquil rubber, Barranquilla, Darien, Panama, Cartagena, Honduras, Nicaragua, West Indian, Guatemala, and Mexican rubber.

The most common species is *Castilla elastica* Cervantes, but other species such as *C. markhamiana* and *C. tunu* occur in different regions. The question of the geographical distribution of the various representatives of the genus *Castilla* is not yet sufficiently investigated.

On the Isthmus of Panama the *Castilla* is quite common in some districts. Mr. CROSS writes about its occurrence in this country :—

"The Caucho tree grows not in inundated lands or marshes, but in moist, undulating, or flat situations, often by the banks of streamlets and on hillsides and summits where there are any loose stones and a little soil. It is adapted to the hottest parts of India, where the temperature does not fall much below 74° F. The tree is of rapid growth, and attains a great size, and I am convinced that when cultivated in India, it will answer the most sanguine expectations that may have been formed concerning it. I have been up the Chagres and Gatun rivers. I came out on the railway about seven miles from Colon. I go back to the same place (the village of Gatun) from which place by the river the India rubber forests are reached."

As to *Castilla* in Costa Rica, Mr. T. F. KOSCHNY states :—

"The safest and most productive rubber plant is the *Castilloa elastica* of Central America. Its tenacity of life and adaptability to soil and climate are seldom exceeded by other trees; the same is also true of the quantity and quality of the rubber."

"It requires a humid, warm climate, and with respect to rainfall less depends upon the amount of precipitation than upon the distribution of it. The shorter the dry season and the more the rain extends over the entire year the better will the locality be adapted for rubber culture; regions with a long, absolutely dry season are unsuitable for this culture. In the valley of San Carlos, Costa Rica, upon the Atlantic slope, it rains occasionally also in the dry season, and even in the two driest months, March and April. The Pacific slope of Central America has, on the contrary, a completely dry season of four months, and two months at the beginning and end with little rain. Both the wild and the planted rubber trees die there at the third tapping at the latest, in case this takes place in the dry season."

COLLINS writes in his Report on the Caoutchouc of Commerce, in regard to the occurrence of *Castilla* in Nicaragua :—

"The basin of the Rio San Juan is where the Ule tree grows to perfection. This river is the natural vent of the two vast basins of the lakes of Nicaragua and Managua, receiving numerous tributaries, which have all their sources in the innumerable tracts hitherto virgin and unfrequented, where the trees abound. The ground is very fertile. The district is very unhealthy.

RUBBER PLANTING IN CENTRAL AMERICA.

Throughout the Central American republics very little has as yet been done towards planting rubber. In most of these countries there is a great unstability of government, and foreign capital is not attracted under such conditions. Labour conditions are also very unsatisfactory on account of the frequent revolutionary movements, which sporadically crop up and draw the greater part of the able-bodied men to the ranks either of Government or rebel armies. Transportation also offers a serious drawback, and many prospective planters are deterred from settling because of the reported unhealthfulness of the climate. This latter is not worse than in other tropical countries, and with the advent of the Pan-American railroad, which will connect the south with the north, the country will be opened. In Central America there is plenty of land suitable for rubber planting. A year ago I rode for days through good rubber country in Guatemala.

In this latter republic very little planting of rubber has so far been done. In Northern Guatemala there is only one plantation of any account devoted to rubber. In the other Central American States, rubber cultivation has been commenced on a small scale. In Nicaragua there are a number of plantations, especially near the Pearl Lagoon, on the Bluefields and Escondido rivers. In Panama rubber is being planted, in Costa Rica there are a few young plantations, and in Honduras rubber has been planted as shade for cocoa. In San Salvador some rubber has recently been planted. Altogether there are in the Central American republics as far as I know 12,230 acres under rubber.

During the year 1904 the first attempts at collecting latex from cultivated trees were made in Nicaragua. These experimental tappings were made on a plantation about thirty miles north of Bluefields in the Pearl Lagoon district. The plantation is one of the oldest in the country and belongs to an American, Mr. J. C. HORTER. The trees tapped were raised in a nursery in 1897, transplanted in 1898, and in 1904, at an age of seven years, they measured 17 to 30 inches in girth and 40 to 45 feet in height. Of the 6,000 trees that were tapped the largest received three incisions, the medium-sized two incisions, and the small ones only one. The average amount of rubber per tree was one and a half ounce. Careful attention was given to the collecting and the rubber obtained was of a greater value than the ordinary "Nicaragua syrup," as the rubber of that district is commercially known. A few of the largest trees were tapped repeatedly at intervals of two weeks without apparent injury, and they yielded each time almost the same amount of rubber.

The Government of Nicaragua, a few years ago, issued a decree offering a premium of ten cents for every rubber tree planted, when the number does not go below 250 trees planted by any one person. The decree provides that the trees must be planted sixteen feet apart. Very few planters have, however, seen fit to accept this offer.

According to recent press reports the devastating cyclone, which visited Central America a few months ago destroyed most of the Bluefields plantations. It is estimated that some 450,000 well developed trees were thus broken and uprooted.

In August, this year, the Government of the Republic granted a concession to a syndicate for the revenue from the exportation of crude rubber from the Department of Zelaya and the districts of Prinzapolca and Great River. This concession is for ten years, and among other requirements from the concessionaries there is one that they are obliged "to employ only expert rubber "cutters who strictly comply with the requirements of Article 11 "of the Regulations of October 15, 1901, which say: 'It is "prohibited to make incisions into the trees to the extent of "penetrating the woody part. Incisions of more than one-half "of the circumference of the trunks or limbs of the trees are also "prohibited.' The contravention of this article shall be punished "by a fine of $5 for every tree damaged." On account of this concession it is now required that a planter who wants to export his rubber, must produce at the custom house a certificate from the authorities of the district where the plantation is situated specifying the locality whence the rubber comes. The Government of Nicaragua has imposed a tax of 5 cents on every pound of rubber exported from the country.

In the value of exports rubber appears as the fourth. All of this is collected from wild trees. The amount shipped from San Juan del Norte to the United States in 1905 was 473,389 pounds.

On the cocoa estates in the Rivas district rubber trees have been planted as shade. In Costa Rica rubber has not proved a success as shade for cocoa. In this latter country rubber is cultivated near the coasts and on the Nicaraguan frontier. Several varieties of *Castilla* are grown, but the plantations are not yet in bearing, so that definite results as to the yield of these forms are still uncertain. In 1905 about 160,000 pounds of wild *Castilla* rubber was exported from this country.

PLANTING IN MEXICO.

One of the first attempts to cultivate rubber in Mexico was made by the Hon. MATIAS ROMERO who in 1872 planted 100,000 trees near Suchiate River in Soconusco, on the Guatemalan border. The owner had to abandon the place for political reasons and the plantation was gradually destroyed by native rubber collectors and by fire, so that at present there is hardly any trace left. On the identical spot of the old plantation a new one has been started in recent years by a relative of Señor ROMERO. When I visited the place about a year ago, it was in a thriving condition. Some thirty years ago Don EUGENIO SANCHEZ on the Teapa river in the State of Tabasco planted the first rubber trees. After that the PRATT and ALFARO families planted rubber, and about 22 years ago most of the farmers in the Teapa and Pichucalco valleys commenced to plant extensively. For the past twelve years there has been a steady increase of the planted area. In the Rio Seco Valley, DON AUGUST LITZOFF has now about 100,000 trees, two to nine years old.

On the upper Grijalva, above Huimanguillo, there is a line of farms for about 30 miles; most of these are tapping 10 year old trees. Señor ABALOS, of Huimangillo, cropped an average of 14 ounces rubber from his 10 year old trees last year.

All this was done on a comparatively small scale, however, the plantations being in Mexican hands not consisting of more than a few thousands or tens of thousands of trees. About 18 years ago a number of rubber trees were set out as shade for cocoa on La Zacualpa, in Soconusco, by the then owner, Señor PALAEZ. Of these there are some 1,000 trees left, and they have been regularly tapped for many years, the trees now presenting a very scarred appearance as a result of the primitive method of tapping employed by the native huleros.

Less than ten years ago American capital was attracted towards rubber planting in Mexico. As a result of this movement we have to-day approximately 100 plantations, entirely or partly devoted to rubber. I have in my possession letters and data showing that the whole area under rubber in Mexico to-day (December 1, 1906) is at least 82,620 acres. I think it is safe to say 90,000 acres. Next year's planting, at a low estimate, will be 10,000 acres. In this total I have not included what "has been" planted, but is no more. And I do not believe the entire area mentioned above can be counted upon to become producing.

In order to explain this I have to mention that it is estimated that this area under rubber represents at least £6,000,000, that is nominally invested in rubber plantations. A considerable part of this money has never reached Mexico, but has been squandered by promoters in America. A very large amount has also been lost through the ignorance of many so-called planters and plantation managers.

RUBBER CULTIVATION IN THE EXPERIMENTAL STAGE.

While I am willing to admit that rubber culture has passed the experimental stage so far as the possibility of producing rubber is concerned, it cannot be denied that in regard to proper agricultural methods this industry is still in its undeveloped childhood.

It has been clearly demonstrated in the progress of many agricultural industries, that very little advance is made before the persons concerned have learned to appreciate the value of co-operation for the purpose of comparing their individual experiences and to take advantage of knowledge gained by previous experiments. Among the rubber planters and plantation managers in Mexico and Central America there is, however, no such co-operation whatever. Everyone is satisfied that he has employed the right methods of planting, although in most cases he started without any previous experience. The correct methods are by no means ascertained beyond any question of doubt at present. But if a person visits a great number of plantations in different districts or countries, he cannot fail to observe some of the advantages or disadvantages of the various methods employed.

We may be able to advance certain theories regarding planting operations, we know that the rubber tree under certain conditions will grow well, we may be able to extract and prepare a certain amount of rubber from the trees, but we cannot yet say which method of growing rubber will give the largest possible return, we do not know whether the most rapid grower is the best producer, and in regard to the manner of obtaining the rubber we still remain on a very primitive footing.

The experimental era of rubber culture, instead of being short and inexpensive, is growing too long for these modern times and it has certainly been unnecessarily costly. Where the experiments should have been conducted on a small scale by persons specially prepared to do this kind of work, the whole *Castilla* planting industry has been one colossal experiment in which millions of money have been staked on the integrity, possible intelligence, and probable good fortune of men, who in many instances have lacked every experience of tropical planting, and in some cases had not even been in the tropics before undertaking the management of a plantation. Millions have thus been literally thrown away, companies have gone bankrupt, and plantations have been abandoned. Those that have survived up to the present time will in due course become a success, at least in the majority of cases. Exaggeration has been the keynote in the promoters' circulars, and inexperience the cause of most failures.

SOME MEXICAN PLANTATIONS.

I have in a previous publication (Bulletin II, La Zacualpa Botanical Station, "Notes on Rubber Culture in Mexico") tentatively divided Mexico into a number of rubber districts, the northernmost being that of Tierra Blanca, in the State of Vera Cruz. The number of plantations in this district is small. Among these may be mentioned Hacienda Yale, owned by a number of former students of Yale University, and La Esperanza, first started by Mr. GEO. CULLEN PEARSON, representing British capital.

Not far from Perez station on the Vera Cruz and Pacific railroad is the Playa Vicente district, containing several small plantations. In this neighbourhood, along the Papaloapan river, are a number of other rubber plantations which all can go under the name of the Tuztepec district.

Further south, and not very far from Santa Lucrecia we have the important Trinidad River district. This is often included in the general term of "the Isthmus" but conditions are in many respects different from those on the Isthmus proper. This latter is a very large district comprising the rubber country along the National Tehuantepec railroad, and along the Coatzacoalcos river or its tributaries.

One of the largest plantations on the Isthmus is Rubio, situated some distance from the township of Minatitlan. It is owned by the Tehuantepec Rubber Company of New York. Its able manager is Mr. A. B. LUTHER, who has had a long Mexican experience, and also has studied conditions in the South American rubber districts. Rubio plantation has some 3,000 acres under rubber. Oaxaqueña, Columbia and Del Corte are some of the other large rubber plantations in the district.

In the Trinidad River district the largest plantation is La Junta, owned by the Mexican Mutual Planters' Association, of Chicago. It has some 4,500 acres under rubber besides a large acreage in coffee and cocoa. Its manager is Mr. J. C. HARVEY, who also is part owner of an adjoining rubber plantation, Buena Ventura. Here Mr. HARVEY, who is very much interested in botany, has a small botanic garden of his own, the only one, in fact in the country. Some fifty different species of palms, a good sized collection of native and foreign orchids, many economic plants, and ornamental trees and shrubs surround his house. The only Para trees yet grown in Mexico are to be found here, and are Mr. HARVEY'S special treasures. Many of the trees and plants in this colleetion are raised from seeds obtained from Singapore Botanic Gardens, with the Director of which Mr. HARVEY is in frequent correspondence.

Another very extensive rubber district is situated along the Grijalva river, and the Usumacinta river system constitutes a district covering a large area. Lastly on the Pacific slope of Chiapas, between the towns of Pijijiapan and Tapachula, we have the Zacualpa district, very limited in area.

Some eighteen years ago *Pelaez*, then owner of La Zacualpa, in Soconusco, planted rubber as shade for cocoa, and of these trees a number are still left and are being tapped every year. In 1899 Mr. O. H. HARRISON, a coffee planter, bought Zacualpa and immediately commenced planting rubber. The plantation which was later transferred to La Zacualpa Rubber Plantation Company, of San Francisco, California, is now probably the largest individual rubber plantation in the world and will when ultimately completed consist of 12,000 acres under rubber. The variety grown is *Castilla lactiflua* Cook. In 1905 the first tapping from young trees was done, some 25,000 trees, between five and six years old, being lightly tapped. Six other rubber plantations have been started of late years in this district, two of which, Juilapa and Zacualpa II, are also under the general direction of Mr. HARRISON. These three sister plantations have now over 8,000 acres under rubber varying in age from 6 months to 6½ years.

In order to show how rubber planting is done in Mexico, and how we expect to handle the plantations and the crop of latex and rubber, I will describe somewhat in detail the conditions on La Zacualpa, and the methods which the management at my suggestion intend to adopt for the future.

LA ZACUALPA RUBBER PLANTATION.

The estate which consists of 18,791 acres of land is situated on the coastal plains between the Sierra Madre and the Pacific Ocean, about twelve miles from the latter. The land slopes very gently towards the ocean, and the highest spot of the rubber plantation is about 50 feet above sea level. Two small rivers flow on the outskirt of the estate, which is intersected by several creeks. Part of the land is swampy, and is not planted in rubber.

The plantation is laid out in square blocks, each containing 27¾ acres. There are now over 200 blocks planted. Between the blocks are roads 24 feet wide. The trees are planted 400 to the acre (say 10 × 12 feet) and admitting some failures, each block should contain 10,000 trees. On account of the lay of the land the planted blocks are in two tracts, one about twice the size of the other. All roads going lengthwise in the tract are called avenues and all cross roads streets. The longest avenue is nearly six miles through the planted rubber forest.

The soil is an alluvial deposit of dark colour, of uniform grain size, without any interrupting strata of different physical texture. In the places where borings have been made to ascertain the depth of the soil it has varied from 18 to 22 feet. Because of the physical character of the soil the rise of water from below by capillarity is continuous and even in the dry season, which lasts six months, the trees do not suffer from lack of water. The root system of *Castilla* on this soil is superficial. In other districts where the soil is stratified, I have found that the roots penetrate much deeper in order to reach the water supply. Laboratory experiments have shown me that roots of *Castilla* seedlings in 42 days have grown to a length of 3 feet 4 inches in order to reach a water supply, which by mechanical arrangement was gradually distanced from the roots in proportion to their growth. In the same time roots of *Castilla* seedlings in the undisturbed soil on Zacualpa did not reach a greater length than 8 inches. A few years ago the land was covered with a layer of ashes through the eruption of a neighbouring volcano, Santa Maria, just across the Guatemalan line. These ashes have formed a cover over the ground which materially assists in checking evaporation. The fertility of the soil is not unusually high, so that we may in time have to apply fertilizers. Experiments are now being conducted to ascertain the results of manuring this soil for rubber. The soil is rather poor in nitrogen and it has been found that the growing of leguminous plants between the rubber trees markedly influences the development of these.

If I add that the plantation is comparatively little exposed to high winds I have shown some of the reasons why I consider the natural conditions of this place nearly ideal for *Castilla* planting.

The method of planting first employed was to sow the seeds in nurseries, and when the seedlings were 4 to 6 months old they were transplanted. Very often, however, transplanting was not done before a year after sowing. The plants were then from five to twelve feet high. The seedlings were cut 5 or 6 inches below the surface, and topped, leaving a pole some 3 feet long. Tied into bundles, which were packed on mule back, these poles were carried to the field. With a pointed stake, holes were made in the ground about one foot deep, the pole placed in the hole and the soil pressed close to the stem. When this planting was done carefully and if rain fell within the next two or three days not more than 3 or 4 per cent. of failures occurred. In places where the soil was somewhat sandy the failures were more frequent. On Zacualpa as many as 18,000 trees have been planted per day in this manner. At first it was believed that shade was necessary, but it was soon noticed that this idea was erroneous and a system of planting in semi-shade was adopted. When clearing a certain amount of high forest trees were left standing, about four to the acre. It is now demonstrated, however, that even this amount of shade is too much on Zacualpa. On the other plantations, however, Juilapa and Zacualpa II, this semi-shade is beneficial as it assists the young plants through the dry season. These plantations are situated at a somewhat higher elevation, and the land is undulating and more drained.

Later experience has proved that the cheapest and surest method is to plant the seeds at stake. Nearly a year's growth is thus gained, and it does away with the expensive replanting where failures occur under the transplanting method. The seeds are planted in small hills, about seven seeds in each hill, three inches between the seeds. The hills are at a distance of about seven feet, in rows twelve feet apart. This method of planting appears at first sight decidedly wrong as the plants stand too close. A planter of Para rubber naturally thinks of the price of every seed he puts in the ground, but this is a minor consideration in the case of the small and rather cheap *Castilla* seeds. On Zacualpa we have the seeds for the picking, and any quantity of them.

In planting in the manner described we allow for a high percentage of failures in germination, we are prepared to give ants, lizards and field rats their due amount, and we still have plants in abundance. This is no theory but has been practised for several years with success. There are no complete failures in any hill, except where planting has been done in ground which is too sour. In such places we may have to replant in small patches after proper draining has been prepared for, and in such cases we use excess plants growing in the neighbourhood. During the first few months seedlings if backward, misshaped, or where crowding is observed, are cut out at the time of each weeding. Generally we cut at least 50 per cent. of all the seedlings during the first six months. Detailed rules have been worked out for this first thinning and they will be applied in the field by the assistants in charge. Great care is exercised in the selection of the plants allowed to remain, and many points have to be attended to. Thus if a plant branches in a way that does not promise regularity, or if it has grown twisted or bent it is cut out. In selection those plants that show a tapering shape with thick stem are preferred to plants growing mainly in height, and plants with large dark green leaves are preferred to those with small leaves of a lighter or yellowish colour.

ADVANTAGE OF CLOSE PLANTING.

One of the great advantages of this system of close planting and successive thinning is the opportunity for selection, a matter which is generally overlooked, but which, no doubt, will be found to be a most profitable policy. In *Castilla* cultivation we often get trees which produce very little or sometimes no rubber. It is evident that such trees are an unnecessary expense on the plantation. Why should we waste time on valueless trees ? Can this in any way be avoided ? With our present limited knowledge of the nature of the tree we cannot say with absolute certainty whether a seedling will become a good "milker" or not. But in the course of my physiological investigations of *Castilla*, I have already been able to draw some conclusions, which give us certain indications on which we can judge in this matter. That is to say, we can in some instances say definitely that a seedling, which shows certain characters, will never produce a large amount of latex. On the other hand, we cannot guarantee that a number of non-producing trees would not be passed during the selection time. But we have found a way to reduce their number, and I hope that further investigation will considerably improve the method. There is, however, another important point which can be applied in this process of selection. It is the choice of rapid growing, healthy plants of a certain desirable type. It is of the greatest value to the planter to have trees which are as rapid growing as possible. Now with the transplanting system a certain amount of selection can be done, but this is before the transplanting process, during which the plant is always more or less injured. There is no selection possible after the transplanting. With the "at stake" planting system mentioned we do our most important selection after sowing the seeds. I will presently refer to the selection which precedes the planting.

With the growth of the young rubber trees, successive thinnings become necessary to prevent crowding. It is here the men in charge of the plantation have to exercise their best judgment. We fully realize the necessity of plenty of air and light for the growing tree. If this is neglected the whole system naturally is detrimental. But there is no reason why such an important matter should be overlooked. We have presupposed that we have to do with intelligent planters and superintendents, who realize that rubber growing on scientific and profitable commercial lines is a shade different from potato growing, as our forefathers practised this necessary and honourable industry a century ago.

On La Zacualpa we thin the rubber stand several times every year until the third year, when we have approximately 800 trees to the acre. During the fifth year we tap fifty per cent. of these trees, selecting the poorest and leaving the best trees untouched. We tap heavily, that is, extracting as much latex as is possible. A few weeks later the trees are inspected. Those that have suffered from the tapping are marked and doomed. If they still yield latex they are cut up with numerous incisions, and a few days afterwards the scrap is collected and the trees felled. Those trees that promise to recuperate are left untouched for four months, when they are again tapped in the regular way. After a second inspection they are killed. Exceptional trees which do not crowd upon the permanent trees may be left to the following, or sixth year, when they are tapped with an ultimate view to their destruction. At the end of the sixth year we have 400 trees to the acre.

Many objections have been raised against this method of close planting and successive thinnings. The main point in question seems to be whether the cutting out of a number of trees, leaving stumps with the roots in the ground, would not be preparing breeding places for fungous or insect diseases. I admit that there is some truth in this objection. In talking about rubber planting I am fully aware of the many dangers that may and most likely will arise from pests, animal or vegetable, in our *Castilla* or other rubber plantations. But in endeavouring to find preventives we must first of all be practical. Methods that are impossible to realize in practice are not worth mentioning.

If we are afraid of leaving the roots of rubber trees in the ground, why do we leave the roots and stumps of the jungle trees when we clear the virgin land for rubber planting? There are hard woods which do not decay for a long time, and during the first few years there is a constant decomposition going on, in the ground and above it, of roots, stumps, branches, and even trunks. Examination will disclose the fact that all of these are affected by some fungus or another, and overground parts also by insects. Do these present any danger to the planted trees? They certainly do, but as long as the planted trees are sound, they are not likely to be attacked, and there is hardly any other way of preventing disease than by keeping the trees in good condition. One of the main factors affecting the health of rubber trees is the drainage of the soil. Keep the ground well drained, and the trees will be sound.

It has been suggested that the ground should be stumped before planting, and others have advised digging up the roots after the rubber trees have been cut down. This is all very good, but if we have to stump the ground in preparing our land, I think we had better give up rubber planting, at least as far as *Castilla* is concerned, To stump or dig up roots in an established stand of rubber is also a method not to be recommended, except in rare instances when absolute necessity arises, such as trenching for isolation of a tree affected by root fungus. The roots of the trees interlace, and any injury to these roots from wounding or bruising them is much more likely to permit an attack by fungus mycelia than leaving them undisturbed. In any case, the cost of stumping would be prohibitive in Mexico and Central America,

It has been assumed that the tapping "to death" of alternate trees would be dangerous to the health of the stand. Why is tapping of alternate trees more dangerous than tapping every tree? As soon as all the rubber is extracted, that is in about a week's time, the trees are felled. In that time there has been no opportunity for any ravages of pests. There is a danger from intermediate or catch crops, such as cocoa or coffee, and still they are recommended. How about the jungle belts that should be left at intervals in a rubber plantation? Do not these constitute a danger? Might they not become a breeding ground for pests? Of course, but we cannot eliminate all sources of danger, without making planting impossible.

There are essentially two ways in which we can start a rubber plantation. One is to treat it as an orchard. In this case we are restricted to a small area and we can naturally take better care of our plants, and probably obtain better results from our individual trees, but it costs more. The other method is planting rubber over large areas as we plant forests of other trees. Such plantations cannot receive the detailed care we can give an orchard but they cost less in proportion to maintain. It is here we have to apply the methods of modern silviculture, and we must apply them in a scientific and at the same time practical and economic manner. As for the ultimate financial results they will be almost identical in either case, although as an investment the smaller place naturally presents a lesser element of risk.

SELECTION OF SEEDS.

We have noticed a decided increase in the rapidity of growth for every year since selection of seeds has been practiced on La Zaculapa. This naturally stands to reason. Still the necessity for careful selection of seed for a rubber plantation does not seem to have been accorded the attention it requires. A farmer now-a-days is very particular about his seed corn, and a fruit grower thinks twice before he decides about the kind of tree he plants. Suppose a corn farmer sows seed that is very uneven in size, some fresh in the milky or green stage, others old and eaten by weevils. What kind of a crop will he get? When we want a hardy stock of fruit trees, we take care to select only the best seeds. But a rubber planter seems to think that any seed is good, any tree is suitable as long as it is a *Castilla.* It must, however, be borne in mind that the whole life of the tree, its healthiness, size, strength, its amount of rubber, all depend upon the start it has. Unlike so many other agricultural industries, rubber culture cannot be immediately benefitted by a lesson learned through bitter experience, because a tree, once planted, will last for many years and has to flourish or fail according to its fitness. Mistakes cannot be corrected as easily as in corn growing, or cultivation of similar crops. It is clear that it will pay a planter to exercise care in the first instance, even more care than in the case of many other plants. This does not imply that a bad start is absolutely hopeless, but rather that care and discretion in the beginning will pay in the long run, and will save the planter many disappointments.

It is naturally difficult, well nigh impossible, to make any detailed selection of seeds, when a large planting, say of thousands of acres, is to be done in one season. But the planter can always subject his seeds to the ordinary methods of selection, such as mentioned below.

When commencing a plantation always get the seeds from planters who to your knowledge cultivate their trees and keep them clean. Naturally a tree that is well cared for will supply better seeds than a neglected tree. Choose seeds from trees that look healthy, have straight tapering trunk, a full conical crown, and are known to give a large amount of latex and rubber.

Seeds from young trees, four to six years old, are larger and look better than those obtained from older trees. It is proved by experiments and experience that seeds from such young trees develop into a healthier plant than seeds from older trees. Whenever tha trees are looking yellow or sickly, carefully avoid their seeds. The large seeds are always better than the small ones In regard to size the seeds should be selected by using a screen with meshes one-fourth inch in diameter. All seeds passing through should be discarded. The next step in selection of seed is to place them in a vessel of water, and separate all seeds that float or do not sink rapidly, as these are defective.

INFLUENCE OF MATURITY OF SEEDS.

If seeds are taken from fruits which are not matured and do not have the clear colour of the flesh they will most likely either fail to germinate, or produce inferior seedlings. Experience has shown in regard to most cultivated plants that the maturity of the seed has a considerable influence on the offspring. Immature seeds lessen the vitality of the subsequent seedlings and trees.

I have noticed that seeds from young plants are fuller and more rounded than those from older trees. The seedling from such a seed has smoother and bigger leaves than those developing from seeds with a loose seed coats and ribs on their surface.

The root development is much stronger in a seedling from seed taken from a younger tree, and this is another reason why careful attention should be paid to the age of the parent tree.

There can be no doubt but that planters who are careless and do not select their seed, make a grave error which they will find out to their regret. Thousands of dollars have been wasted by ignorance or neglect in this respect. If a mistake is made in selecting or non-selecting of seeds it will not be realised before the lapse of at least a number of years, when it probably will be impossible to correct the blunder, and make the plantation not as productive as it otherwise would have been.

METHODS OF SELECTION.

The process of selection should commence, as I have pointed out above, with the seeds. Whatever method of planting is adopted the most important time for selection is when the seedling has appeared and grown to a size which permits the distinguishing of its main features. In order to be able to exercise necessary judgment in this selection the planter should be thoroughly acquainted with the development of the plant in its various stages.

I have previously stated that a great variation exists between individual plants. This variability is evidenced in a large proportion of the trees producing a small quantity only and often an inferior quality of latex. Such a lack of uniformity necessitates a subsequent sorting and grading of the latex if a good result is to be obtained. If latex from all kinds of trees is indiscriminately mixed together the result will be a lowering of the standard. From a planter's view-point uniformity of stand is desired, and to attain such a result systematic seedling selection is a necessity.

It has been demonstrated by recent experiments that it is possible to secure by selection a great improvement in the uniformity of the rubber stand. It is equally possible to obtain a considerable increase in yield, and the planter should give the closest attention to these and other points which can be controlled by careful selection. The planter should first decide upon the type of tree he desires and when he has formed a clear conception of this in his mind he should go through the rubber forest, carefully observing the trees and selecting the number of trees he needs for the production of his seeds. When these seeds have been collected and treated in the best possible way, they should be further selected by the screen and the common specific gravity methods. When such seeds have germinated the resulting seedlings will clearly demonstrate the benefit of seed selection. As soon as the young plants have reached a height of 7 to 8 inches it is time for the planter to pass through his fields, eliminating all plants that are defective, backward, or in any other way undesirable.

INCREASED SIZE AND PRODUCTIVENESS.

Only a superficial observation is necessary to show the planter that when a rubber tree is cultivated properly it re-acts to good treatment. If the trees have good soil with sufficient moisture, plenty of light and air, and no crowding competition with other plants of their own or any other kind, they will grow quicker, remain healthier and more robust, and what is most important, they will furnish a greater surface for tapping, than if exposed to the vicissitudes of the natural struggle for life in the forest or in a plantation where the trees stand too close.

If we subject the trees to the best possible treatment according to modern and improved methods of silviculture we will soon be repaid for the additional care bestowed upon the plants. There can be no doubt but that the size of the trunk can be considerably increased by breeding and selection. There can be as little uncertainty in regard to the possibilty of increasing the amount of latex in the tree. These improvements take, however, some time, and the rubber planter of to-day cannot immediately benefit by the gradual advances made in this connection. To him it is more important to take advantage of methods of selection which can be put into practice on his plantation already started. On such a place it is of the greatest consequence that all unproductive, sickly, or otherwise unsatisfactory trees be destroyed. It does not pay to cultivate trees which do not give a payable quantity of latex, and it is a waste of land to keep the ground occupied by such trees, which should be immediately replaced.

In regard to the rapidity of growth and the size of the seedling and the subsequent tree, it has long been conclusively proved that the heavier seeds are far superior to the light ones. Experiments conducted with a view of determining whether the size of the seeds has any effect on the vigour of the plant, have shown that plants grown from the heaviest seeds attain a greater size even if they do not always germinate as rapidly as the smaller. It has further been demonstrated that plants grown from the heaviest seeds have a greater power of resistance to drought.

To insure a good stand and a greater yield, none but the largest and heaviest seeds should be selected, and of the seedlings the most rapid growes, with the healtiest and most vigorous appearance.

EXPERIMENTS IN IMPROVING CASTILLA.

So far, very few experiments have been made for the purpose of improving the *Castilla* rubber tree, or in order to ascertain the growth of the seedling under different circumstances. A series of such experiments were started in April and May of 1906, at La Zacualpa Botanical Station in Mexico. The results of these initial experiments are not yet available for publication, but I have found that so far a marked improvement is noticeable in seedlings placed under favourable conditions and subjected to rational and systematic treatment.

HABITS OF CASTILLA.

When we study the *Castilla* in its native conditions, in the natural surroundings in which the tree has been able to exist and flourish in competition with other trees, we learn many a useful lesson as to its requirements under cultivation. It is by no means essential that a cultivated plant should always have to be grown under conditions identical with those of its original habitat, but we can always derive pointers from a close observation of nature.

One of the first things we notice when observing *Castilla* in the wild state is that it prefers small openings in the forest and that it never selects very heavy shade. In this regard, it is similar to its relative the Guarumbo tree which is always found in localities where the primeval forest has been cleared at some time or other. The Guarumbo, or trumpet tree (*Cecropia*), is very common through Southern Mexico and Central America. It is often called the false rubber tree, because to the uninitiated new-comer it resembles at a distance *Castilla*. As soon as a cleaning is made *Cecropia* will gain a foothold and as it is of very rapid growth, it soon grows into a small tree. I have noticed on some plantations that the managers studiously avoid cutting down the Guarumbo trees wherever they grow among the rubber. I was informed that this was done on purpose as the Guarumbo tree resembled the rubber tree so much that it helped to carry out the impression of an even and good stand of rubber trees. Inspecting shareholders did not notice the difference. I am ready to believe this, as there appears no other reason why the Guarumbo tree should be left standing. It is not good as a shade tree and as it consumes a great amount of water and plant food, it is decidedly detrimental in a rubber stand

In the natural succession of the forest trees both *Cecropia* and *Castilla* are secondary elements. The seed of *Castilla* is so thin-shelled and perishable that it needs a moist place in which to germinate as it would otherwise be destroyed by the heat of the sun. We therefore always find the young seedlings growing close to other trees which give them sufficient protection.

Castilla depends in many other respects upon its neighbours for safety. It is a very brittle tree, easily broken by the wind and therefore needs a wind-break. We always find *Castillas* in the pole stage standing close to other trees, which indicates that they have been able to survive only by reason of the protection afforded by the other trees. It may be inferred that if this is true we would never find a *Castilla* standing separated from any neighbours. I think that in every case where an old *Castilla* tree is found single it has either been planted by man and protected, or, if a wild tree the surrounding trees have been destroyed in some way or other. It is at least on very rare occasions that

Castilla is able to live through the sapling and pole stages without protection against wind.

Another way in which *Castilla* gets protection from neighbouring trees is that these give shelter to the ground, retain moisture, and prevent the soil from cracking. Castilla is very sensitive to these influences, as its roots do not develop properly in hard-baked ground.

Castilla does not, on the other hand, develop well in shade. It grows very slender, with a weak trunk and an undeveloped crown. The tree needs plenty of light for its foliage and it is only where the *Castilla* tree has room enough to spread its branches and expose its foliage to the rays of the sun that it can successfully maintain its position in the struggle for space and light.

In districts where a distinct dry season prevails, *Castilla* is pronouncedly deciduous and drops its leaves at that period of the year, while in a humid region the shedding of leaves goes on all the year round. On the Pacific side of Sierra Madre in Mexico, the dry season lasts from January to May, and the rubber tree begins to shed its leaves with the advent of this season, and towards its close the trees are almost destitute of foliage.

It is generally stated that *Castilla* does not flower and set fruit before it has reached an age of about five years. Another statement is that flowering commences when the tree begins to develop permanent branches. My observations show that if *Castilla* is grown on good soil in a suitable climate, and if the development has been normal, the tree will flower in its third year, whether it has permanent branches or not. I have seen many two years old trees with flowers and fruit, but I would consider this premature, and indicating that something is wrong with the tree.

The season of flowering is from February to the beginning of May in the Zacualpa district in Mexico, and in Western Guatemala. The earliest fruits begin to ripen in May and ripe seeds can be had until August.

The flowers are unisexual, but both sexes occur on the same tree. I have often heard it stated by planters and others, that there are two distinct trees, the male and female. It is also said, and generally believed, that the "male trees" do not produce latex as well as the "female." In my experience all the older trees carry both male or staminate and female or pistillate flowers. While the trees are young they often have only staminate flowers but after reaching a more mature age both sexes are present. I think we can safely abandon the idea that some trees are male and therefore no "milkers," while others are female and good milk producers. Such an analogy is rather far fetched and has a strong flavour of ignorance.

I have found trees on which the female flowers have been sterile on account of insufficient development of the ovary. Such trees naturally do not produce fruit. Whether there are any permanently sterile trees is a question yet to be investigated.

I have seen numerous instances where a tree had no flowers one year but developed a profusion of both staminate and pistillate flowers the next year. I have also noticed cases where a tree had an abundance of fruit one year and none the following. Whether there is any regularity in this development of flowers and fruits I am not in a position to say at present.

The idea that a sterile tree, or at least a tree not carrying fruit produces less latex than a fruiting one is erroneous. I have noticed instances of trees with plenty of fruit giving little or no latex, and again of non-fruiting trees with an abundance of latex. It seems though as if a tree generally yielded more latex while in fruit than during any other time of the year.

The staminate flowers consist of imbricated scaly flat pods, which open along the edge like a clam shell, with clusters of yellowish stamens on the inner side. These pods or heads are up to one inch long, as a rule, but another kind of smaller staminate flowers are found immediately below a cluster of pistillate flowers. The stamens in these semi-spherical heads often have pollen grains which are shrivelled up and apparently sterile.

The female flowers have numerous ovaries on a common disc-like receptacle or cup, covered with scales larger than those of the staminate flowers. Each pistil carries two straight, scarred, two-parted styles.

The fruit is first green, and when ripening gradually turns a deep red, finally fading into an orange colour. From eight to thirty fruits mature in each cluster, and a much larger number never develop but remain in the form of larger or smaller scales. At the apex of every fruit is a small hollow in which the dried up remnants of the style can be seen.

THE BEST TYPE OF A CASTILLA TREE.

We have yet to ascertain the cause of the difference in yield of individual trees, or at least, we must find out what trees are the best producers and the most rapid growers, before we can enter upon the problem of determining or developing the best type for a rubber tree. On general principles we should require a tall straight trunk, with a dense crown at the top of the tree. But the natives hold that a tree which is not too tall and which has a tapering trunk, gives a larger yield and better rubber than a taller tree of the same age and with the same girth at the base. I have been able to verify this by actual experience, but I cannot give any explanation of this fact.

The object is to develop a trunk with as large an area as possible for tapping. Branches seldom attain a tapable size and a rubber stand with clean stems without intertwining branches or underbrush, is easier to work in than in a tangled mass of trees growing without order and care.

We have many instances of large trees with tapable branches, or trees which have branched from the base, being regularly tapped and producing a quantity of latex. It may seem an advantage to have several stems to tap instead of only one, where a single shoot or a single trunk has developed, but there can be no question as to the fact that where several branches are allowed to develop the growth of the main trunk is greatly retarded.

It is therefore necessary to have a tree straight and clean boled, in a condition to make the best of the period of maximum growth, the time of which has not yet been ascertained. We know for a fact that the best rubber producer has a thick, compact crown. The conical form of crown is also to be recommended as it naturally receives more light than a flat crown. After the *Castilla* growing in the wild state has attained its maximum height the crown always becomes flat and rather ovate in shape, while in youth, when the tree is growing vigorously under normal conditions, it has a sharply conical crown. Every kind of tree has a maximum height to which it is able to pump water, and when this height has been reached the growth of the tree ceases because the crown cannot be supplied with sufficient water. The normal rubber tree should not, therefore, be very tall as in the best situations the wild tree reaches a height of about sixty feet, and the over-mature trees always have a very spreading crown. Sometimes dry topped young trees are observed. This is due to unsuitable conditions in some respect or another, and we recognise this as a disease, called by foresters the "staghorn disease."

The leaves should be large, with a fresh green colour, the bark thin and smooth. Some trees have leaves with stiff, bristly hairs, and I have found on some plantations almost every tree covered with these stiff hairs, sometimes resembling prickles. In cases where such hairs occur the trees were below the average in regard to yielding capacity. It seems therefore obvious that hairs should be absent in the future type of rubber trees. There is also another reason for this. We know that the hairs are one mode of protecing the leaves against excessive transpiration. The latex is another means by which the tree prevents its water supply from evaporating too rapidly through the leaves. If we develop a tree without hairs we should be able to force the tree into preparing more latex in order to keep up the equilibrium, not allowing too much water to transpire.

REMARKS ON FUNCTION OF LATEX.

By the above I do not mean to say or indicate that I consider the function of latex as solely one of water storage or prevention of too rapid evaporation. But field observations as well as laboratory and breeding experiments have conclusively shown that the protection of the plants against too rapid transpiration is one of the functions of latex, at least in *Castilla*.

I could give a number of proofs for this, but as the question is more fully discussed in my handbook on *Castilla*, above referred to, I will here mention only one instance, which first fell under my observation in July, 1905. In walking through a stand of four year old rubber trees, one early morning, I stopped and measured some two dozen trees, which were especially well developed. I noted down in my field-book certain characteristics of these trees, and with my thermometers, took the soil and atmospheric temperatures, near one of the trees standing about in the middle of the group of trees measured. I intended to return two hours later, when the full heat of the sun had been acting on the trees to remeasure the trunks in order to find out the shrinkage of the trunks at different times of the day. I was delayed, and returned some four hours later instead, at 10.47 a.m. The first thing I noticed was that one of the trees which in no way differed from its neighbours upon my first visit, was now looking very exhausted, with drooping branches and leaves hanging limply downwards. Another tree standing by looked perfectly fresh, while some of the others showed signs of having been slightly affected by the now scorching rays of the sun. This difference in power of withstanding sudden high temperature was so marked that I decided to try the different trees for latex. The result of a small cut in each tree was that *A*, the tree with drooping leaves, had no latex, while *H*, the most fresh looking tree of the lot, had plenty. Between these *B*, *C*, etc., showed a gradual increase in the amount of latex with the exception of two trees *F* and *G*, of which the latter had less latex than the former, but it was much thicker. This year I noticed the same difference at the end of January. Closer observation now revealed the fact that *A* had much more hairs on the leaves, petioles, and branchlets than *H*, and thus ought to have been better protected against too rapid transpiration, Counting the stomata on the leaves, I found that the number was smaller in *A*,—another protective device. The barkpores were almost equal. Five weeks later *A* commenced to drop its leaves, and was almost bare at the end of March, when *H* still had all its foliage left. *H* did not commence to drop leaves before the last week of April, and did not lose many before the rainy season set in, and new leaves were again developed. *A* recovered rapidly in June, after the rains began, and was soon clothed in full foliage. In January, *A* had a small amount of latex, and whenever cut during the dry season a few drops appeared in the wound. After a few weeks of rain no latex appeared from an incision, i.e., the tree behaved exactly as it had done in the rainy season of the previous year. *H* had an abundant supply of latex in the wet season, and in the dry part of the year this latex was still present, but was less watery, or more concentrated.

How are we to explain this fact that a tree, such as *H* in the above experiments, with less of ordinary protective devices, but more latex was better able to stand excessive transpiration than *A*, with rather well-developed protective arrangements, but only little or no latex ? I think the only answer is to be looked for in the presence or absence of latex in respective trees. Both were vigourously growing trees, and *A* did not seem to be much handicapped by the absence of latex, except in regard to transpiration. When having the advantage of a humid atmosphere and plenty of water after the beginning of the rains, the tree grew as well, and almost better than the others. It is also worth noticing that in the dry season a small amount of latex appeared. It was all the tree was able to produce for its protection against rapid transpiration, and by means of this and an early leaf-fall it could survive the vicissitudes of the drought.

I will also briefly relate one of my laboratory experiments, which has a bearing on this matter. Two *Castilla* seedlings were grown in pots, and when they were four inches high one was placed under a double glass bell, the outer room of this filled with an orange-coloured liquid to give the desired light, and the inner bell constantly filled with well saturated air. The other seedling was placed in a bottomless glass cylinder, and by means of a fan, kept going by a clock movement, a constant exchange of air was secured in the cylinder. This was further placed so that it was exposed to the sun all day long. The roots received all the water they could absorb, and thus the transpiration was kept at a maximum. First the latter plant was very weak, but gradually recovered strength. After three weeks both plants were examined, both micro- and macroscopically as to latex. The plant in the moist air had well developed latex vessels, but the liquid in these was thin and without any formation of globules. The plant which had been exposed to excessive transpiration had the ordinary latex of young seedlings, but rather concentrated. To make sure that this result was not merely caused by an individual or inherent character of the seedlings employed, I renewed the experiment, taking care to select seedlings which did not appreciably differ in any respect. The result was again the same.

I consider that this shows that when *Castilla* is grown under certain conditions the quantity of latex produced in the tree is reduced to a minimum, while under conditions favourable to or assisting excessive transpiration *Castilla* will produce latex *as a means of protection.*

How are we to explain the fact that *Castilla* in some places in the mountains of Southern Mexico, where the rainfall is high and the atmosphere laden with moisture, does not produce latex, or at least a very small quantity? I take it to signify that in those places the transpiration is less than on the plains. This is, of course, only assumption, and the question is still open.

It has been claimed by certain theorists that the sole or at least the principal function of latex is protection against the natural enemies of the plants. How is it then that those individual trees of the same species, which do not produce latex, are not instantly devoured by insects and other pests? Let those who know answer this. I think that the conclusion of latex being solely a protection against insects or other animals is as narrow as the theory that spines are developed on certain plants for the same purpose, solely for protection against animals. No plant physiologist or ecologist who has studied the question in nature would now-a-days maintain this. I do not deny that latex in the rubber trees may *incidentally* be a means of protection also against insects, but this certainly is not its main function.

TAPPING OPERATIONS ON LA ZACUALPA.

There has been a great difference of opinion as to the age at which a *Castilla* tree can be tapped. We have, however, to go more by size than by age. In one district the average tree may reach a tapable size when 6 years old, in other places not before 10 years of age. A definite rule can therefore hardly be laid down. The term of 6 years was tentatively put forth by most planters in the early days of planting, that is 5 to 10 years ago. Now I would say that the gathering of rubber from trees less than 8 years old is not likely to be advantageous. On Zacualpa we tap in the 7th year all trees with a girth of 28 inches at three feet from the base. Such a tree takes four incisions, nine inches long. In the 8th year we expect to tap all trees down to 25 inches, and this minimum girth for a tapable tree will then be maintained. After the 8th year the greater number are probably ready for tapping. One incision drains a larger area on the stem than in *Hevea.*

It is well known that rubber from three to four year old trees is decidedly inferior. Consequently we cannot go by size alone when we speak of young trees. The size has, however, more to do with the productiveness than the age. But we must take the "maturity" of the latex into consideration.

In order to keep track of all work performed on the plantation a series of observations are to be made by the assistants, and the data thus obtained will serve as a guide in laying out our tapping plans. As I have already mentioned the plantation on La Zacualpa is laid out in square blocks, All records in connection with each separate block are filed on cards, such as are now common in most American business houses. The blanks are printed ready and the cards appear something like the following figure, when completed with notes :—

Block No. 76. *Planted* June 25th 1905. *Last Weeding.* Dec. 19th 1905. *Today's work.* Weeding. 5 men.	Harrison *Avenue.* 22nd *Street.* — 23rd *Street.* Weeding finished. *Drain.* 2 trees dropped. Somewhat crowded. White ant-nest destroyed to-day with carb. dis. Stand is now perfect. 5 trees slightly injured by wind. Branches need chopping. Butler *Avenue.*	*Notes by* F. Marx. February 2nd 1906. *Remarks.* Main drain corn. Harr. & 22nd needsimmediate attention. Wind of January 27th did slight damage.

Each assistant will be supplied with a note book, the pages of which are ruled in the above manner, and he is expected to make field-notes of any observations made during work or while riding over the estate. The notes are written on the card in a position indicating the place in the block, so that the men in the office are able to direct a foreman to attend to any small matter needing adjustment. From these cards maps can be drawn showing the exact condition of the plantation at any special time.

These notes are handed to the superintendent at the end of the day's work and then copied on permanent cards which are filed in drawers in special cabinets. In this manner a large amount of detail is always ready for reference, and the history of any particular block can be learnt in a few minutes time. With this system we will not be much handicapped through changes in the staff, as a new assistant with ordinary intelligence can grasp the details of the plantation in a few days. Similar notes are to be kept of tapping and all other operations in the field.

We have fully realized the necessity of training our tappers, and we expect an ordinary tapper to cut 1,000 incisions per day, that is to say, tap 250 trees with four incisions, up to one foot long. Tapping should be done between 5 and 11 a.m.. Evening tappings will not be practised as the distances are too great, and it would not pay to have the men walk several miles to tap probably one hour in the evening. Moreover, in our rainy season it almost invariably rains in the afternoon, and tapping must cease during a heavy rain to prevent loss of latex from washing.

The problem that faces us within a few years on La Zacualpa is to tap over two million rubber trees. We know that we have to tap these twice in the six months season available. A simple mathematical calculation shows the amount of labour necessary, as well as the great importance of our developing as economical and labour saving methods as possible. Fortunately rubber is a crop which will stand more expensive labour than almost any other tropical product, even if we had a drop of over 50 per cent. in the present market prices.

In tapping a *Castilla* tree all the latex exudes from the wound in a time varying from 20 minutes to two hours. After that time very little latex appears. Two days after tapping all wounds are inspected and cleaned of scrap. If an incision has been too deep, penetrating into the wood, the wound is disinfected by the scrap collector, who for that purpose carries a brush and a can with a mixture, the application of which prevents fungi from getting a foothold. A normal wound, where the wood is still covered by cambium, heals quickly and is not, as a rule, attacked by borers or fungi.

The amount of latex obtained from a single tapping is so large that on old trees quite good-sized cups are needed. The system of pushing the edge of the cup under the bark is not suitable on *Castilla*, as latex will run to waste from the wound made, and the hold of the bark on the rather large cups is not sufficient. They sometimes drop, and this must be prevented. Driving nails into the trunk results in bad cankerous wounds, and with the system of tapping employed the number of nails on each trunk would soon be considerable. The cup is made with one side slightly curved inwards to suit the trunk approximately, and from one side of the edge of the cup a string is led round the trunk, and with a hook fastened to the other side of the cup. The placing of a cup on the trunk is done with less manipulation than is needed to press the edge under the bark or driving in a nail and hanging a cup on.

The latex is emptied from the cups into small galvanized cans holding 2½ gallons each. These are carried to the nearest collecting depot, never more than 600 yards away, where the latex is weighed and collected into big cans, somewhat like the large milk cans used in dairies. From here the latex cans are transported on wagons to the rubber factory. All cans and cups are rinsed with clean water at the depots, and at the end of the day's work placed in a small shed, erected at each depot. Here are kept all the tools needed, in order to save the transportation back and forth every day to head-quarters. As the latex from young trees is very apt to coagulate before reaching the factory, a small amount of formaldehyde is added to each can by the foreman in charge of the depot, where collection has been made. One depot is the central station for each series of four blocks, and thus the depots are placed at every second crossing along alternate avenues. Communication between the depots is made easy and one assistant is able to supervise the work at a larger number of depots, than if they were scattered about the plantation. In the office every depot is known by a number, marked on the map, and during tapping control can easily be kept of the returns from each depot.

The rubber plantation will further be divided into four fire districts, each with a patrolling watchman, who by easily accessible field telephones can quickly report to head-quarters when necessary. The labourers are at present divided into two camps, one at the "finca" as the buildings of an estate are called in Mexico, the other some 3½ miles distant in the middle of the rubber plantation. In the future an electric tram system will be laid out to facilitate transportation on the estate. The new Pan-American railroad passes within a few miles of the plantation buildings, and La Zacualpa station will mark the place of communication with the outer world.

THE PREPARATION OF RUBBER.

At present the rubber factory is in temporary quarters under the roof of the estate saw-mill. A proper factory building will be erected next year. Briefly stated, the system of preparing rubber which will then be adopted, is as follows :—The latex brought in from the field is emptied into a collecting tank, where an equal amount of water is added. Inside this tank is an endless screw which slowly revolves and thus mixes the latex and the water without causing a separation of the natural clumps of globules.

In case the preparation has to be postponed, a small amount of dilute formalin is slowly added from an automatic drip-can. From the collecting tank the latex passes through a strainer into a stirring vat, where more water is added, and the mixture is well stirred; the temperature being slightly raised with steam passing through pipe coils inside the vat.

If we adopt a smoking or fumigating process, which is not yet definitely decided, the latex should next pass into a zinc cylinder and through a series of sieves between which the fumes are pressed. The thoroughly fumigated latex falls into a vessel whence it is run off, fifteen minutes later, into settling tanks. Here the creaming of the latex takes place, and by very gentle stirring of the top layer of "cream" coagulation is assisted. Sometimes a coagulant has to be added, but more often the latex shows a tendency to coagulate too rapidly. From time to time some of the mother liquid, which is dark brown, resembling beer, is drawn off from below and clean water is slowly added.

The coagulated rubber slabs are passed on to the washing machine, and after a thorough washing the rubber is dried *in vacuo.*

It is very difficuit, even by adding coagulants, to effect the coagulation of all the rubber in the latex. As an adjunct to the creaming process all of the remaining latex, after two creamings, is passed through a centrifugal separator, and after this the mother liquid does not contain any more rubber.

All the rubber is pressed into blocks in a strong screw press after drying. Two years ago MR. HARRISON prepared with tartaric acid on La Zacualpa a big rubber block as an experiment and it proved to be the most attractive and practical way in which we can ship the clean plantation *Castilla.* I have received the advice from English rubber brokers to send *Castilla* rubber as crepe, but I greatly doubt the advisability of this, as the oxidation would be considerable, and *Castilla* suffers more from this than Para rubber.

SULPHURIZING THE LATEX.

The addition of finely pulverized sulphur by a process corresponding to the vulcanization suggested itself in the early stages of my experiments with *Castilla* latex in the laboratory at La Zacualpa. This sulphurizing the latex is, of course, easily feasible, but beyond its preserving action on the crude rubber there is very little to recommend it to the planter. From the manufacturer's point of view, however, a very strong objection will be raised, and it seems to me this cannot be overlooked, In whatever way we add solid sulphur to the latex, the quantity will vary on different plantations and no uniformity can be achieved. This method further lends itself to adulteration, which the rubber buyers always seem to be afraid of. It would in every case be necessary for the manufacturer to analyse his crude rubber for sulphur, and in most instances he would have to desulphurize the rubber before vulcanizing. As the rubber must be masticated before it is mixed with the various ingredients necessary in manufacturing different articles, there is nothing to be gained in the way of preserving the "nerve" of the rubber.

I mentioned above the disinfecting and preserving action sulphur would have on the crude rubber. My series of experiments on sulphurizing latex and preparing rubber from thus treated material consisted of 63 different experiments, each varying from the others in some more or less important respect. I made good samples of rubber, and bad ones, from the sulphurized latex. In most cases there was no development of bacteria in the rubber, even though the samples of rubber were exposed in the culture jars to an atmosphere full of spores of moulds and decaying latex was poured over the rubber. Inoculation of bacteria cultures made of different forms occurring in "tacky" rubber was tried, but failed to develop on samples where a thorough admixture of latex and sulphur has been accomplished. The preserving power of sulphur mixed into the latex seems undoubted.

I have tried many various methods of smoking the *Castilla* rubber, and of coagulating by means of smoke. The most successful one is, I believe, the following. The fumes of burning sulphur were pressed into the latex for varying periods, and it was found that this assisted considerably the coagulation. I then mixed fumes of burning sulphur with the smoke of creosoted wood, pressed this mixture through a cooling apparatus to slightly bring down the temperature, and thoroughly fumigated the latex. This coagulated quickly and gave a grayish rubber, perfectly transparent, with a high degree of tensile strength. It has not deteriorated in the six months that have passed since the experiment was made. Whether this method will be incorporated in the manufacturing process on La Zacualpa depends on further experiments. The present results indicate that there is a possibility in this direction.

RUBBER EXPERIMENTS.

Before ending this brief description of conditions on La Zacualpa, I wish to say a few words about the experiments which are being conducted at La Zacualpa Botanical Station and Rubber Laboratory. This institution began its work on December 1st, 1905. Its purpose is the scientific investigation of the various problems connected with rubber culture. In the short time of its existence the station has not been able to accomplish very much besides laying the foundation to a systematized study of *Castilla* and *Manihot* rubbers. Considerable time was taken up in organizing the work, and in equipping and arranging the laboratories. These consist of a chemical laboratory, fully equipped with all necessary apparatus and re-agents for analytic and experimental work; a plant physiological laboratory supplied with ordinary instuments and microscopes; a bacteriological department with all the paraphernalia pertaining thereto, incubators, sterilizers, microtomes, and microscopes; a rubber experiment department with various appliances; a shop for making models and repairing instruments;

a library with reference books, literature on chemistry, tropical agriculture, entomology, botany, coffee, and rubber, about forty periodicals, and some 4,000 pamphlets on agricultural and related subjects.

Our first work was to take a survey of conditions on the rubber plantation. Detailed observations were made of the rubber over the entire estate. These data were copied on cards such as intimated above. Maps were made shewing the condition of the rubber on different areas and from different points of view. Suggestions were made as to treatment of the rubber stand. A drainage system was partly worked out. 30,000 trees were measured to ascertain the average girth and height of trees of various ages. Observations on branching, leaf-formation, root-development and light requirements were made. A complete working plan for 30 years was formulated and submitted to the managing director. Insect and fungus diseases were studied and remedies tried. Means for preventing forest fires in the rubber were suggested.

A number of well-developed young rubber trees were selected in the field and transplanted to the experimental grounds, which had been opened. Here seeds of different *Castilla* varieties have been sown. Ceara and other rubber-producing trees and vines have been planted. It is intended to get a complete collection of the world's rubber and gutta percha plants. *Castilla* seeds have been sown under varying conditions of soil to ascertain the difference in development. Manuring experiments have been commenced. Influence of catch crops is being studied. Observations are made as to the best method of weeding, and the result of this as shown in the progress of the rubber trees. Pruning and transplanting experiments are going on, as well as experiments in grafting and hybridizing.

In the course of the plant physiological work experiments on transpiration have been commenced; the temperature of the tree and of the latex in the tree is ascertained under different weather conditions; the effect of wounding is studied; root and bark pressure is experimented upon; relation of leaf-fall to latex is one subject of investigation; several other lines of inquiry have been entered upon, and numerous new problems will be studied in the future.

The bacteriology of latex and crude rubber is not entirely unknown, and we have ascertained some very interesting facts. Before these are published, however, the flora of the crude rubber is being classified by a specialist and the enzymes are carefully investigated. We have tried over one hundred different chemicals in regard to their disinfecting power, and we have no difficulty in preserving the latex for a considerable time. By the addition of formalin to the latex it can be kept for at least 27 months without changing its character. This is the oldest latex I have had to deal with, but I am inclined to believe that the latex can be kept indefinitely. I have deposited in La Zacualpa laboratory samples of latex, which are now 11 months old, and I put up a sample with formalin in June 1905, brought in to Stanford University in California, where I last saw it in September 1906, apparently in the same condition. The 27 months old sample above referred to was given me by a Mexican rubber planter, and I made from it a sample of rubber, which in no way differs from that coagulated from fresh latex. Salicylic acid in small quantities has proved to be a good disinfectant of the latex, but I do not know how it would affect vulcanization. Creosote coating and other methods of mixing creosote into the latex and rubber have been tried.

A suitable hydrometer for measuring the density of latex has been devised and is used with success.

Analyses of rubber soils have been made, and one series of analyses of special interest is that of the soil on Zacualpa down to a depth of 20 feet. Numerous analyses of latex of *Castilla* and *Manihot* have been made, as well as of crude rubbers. The chemical constituents, especially the resins, in latex from trees of different ages are being compared and studied.

Soil temperatures on the rubber plantation are taken at regular intervals and comparative studies made of these with the tree temperatures, and the ordinary meteorological observations taken daily as to temperature, wind, light, humidity, atmospheric pressure, evaporation, serve as a basis for all our studies of the ecology of *Castilla*.

One of the assistants made a four weeks' journey of inspection to the Isthmus and Trinidad River rubber districts in May, and the director of the station was dispatched in September, on a voyage round the world in order to study conditions of rubber cultivation in various tropical countries as well as market conditions in Europe and America.

The station has been fortunate in having the confidence and unlimited support of the managing director of the company, Mr. O. H. HARRISON, who is ready to listen to and accept all suggestions based on actual scientific observation and conforming to sound business principles. Many Mexican planters have recognized the work on Zacualpa, and among others the President of the Republic follows the station with the closest interest. We are often asked questions in regard to rubber culture, but as the institution is a private one, we have not been able to devote time to giving directions to outsiders. A series of bulletins will however, be published, giving the most important results of our work. Three of these bulletins are in press, but will not appear in print, before the return of the director to Mexico.

CEARA RUBBER IN MEXICO.

The only attempt to cultivate Ceara in Mexico was made a few years ago by Mr. O. H. HARRISON on his Esmeralda coffee plantation, some 12 miles from La Zacualpa, at an elevation of ,2000 feet, on the slope of Sierra Madre.

Mr. HARRISON had considerable experience of rubber in Brazil, and it struck him that Ceara rubber would be a suitable crop on the highlands of Chiapas. Seeds were procured from Brazil and planted on Esmeralda. The plants were left almost entirely to their own device receiving very little care beyond a few sporadic weedings. Compared to other Ceara trees I have seen they have not developed very well, but the amount of latex is satisfactory. Tapping experiments will be conducted regularly on these trees, a few hundred in number.

GUAYULE RUBBER.

The invention of a practical method of extracting the rubber from the Guayule plant of Northern Mexico has led to over-sanguine estimates of results from this new rubber industry. Factories are being erected in numerous places, and the periodic press reports the floating of one big company after another for the purpose of exploiting the Guayule covered plains of the north of Mexico, and of certain districts in the southern part of the United States.

In considering the development of the *Castilla* rubber industry of Central America it is necessary to pay some attention to the reports on the Guayule product, especially because it has been maintained by some promoters interested in the question that the Guayule would supersede the production of all the other rubbers, that the Guayule would lower the prices in the world's market to such an extent as to render cultivation of *Castilla* and *Hevea* an impossibility, and that the Guayule would supply the entire demand of the world for crude rubber. I shall here briefly discuss the question.

The much advertised Guayule rubber is obtained from *Parthenium argentatum* A. Gray, a shrubby plant belonging to the family *Compositae*. This plant occurs in the bush prairie formations of the northern part of the Mexican highlands, or more specifically, in the northern districts of the states of San Luis Potosi and Zacatecas, in Chihuahua, in the eastern part of Durango, and in the southern districts of Coahuila. In the United States the plant occurs in Texas, New Mexico and Arizona, in limited areas.

The supply of Guayule has been greatly over-estimated, principally because of the confusing of Guayule with another species of the same genus, *Parthenium incanum* H. B. K., which is far more abundant and grows all through the Guayule territory. This has been estimated to as much as 28,000 square miles, but it must be remembered that the patches of Guayule are far apart and one can travel over miles in the Guayule country without seeing a single specimen. The general estimates of Guayule on the acre is from 400 to 790 pounds, taking an average for large areas. This is undoubtedly too high an average. By actual count in very favourable localities I have become convinced that even under the best conditions not more than 1,500 pounds can be obtained per acre from the Guayule patches, and these constitute less than one-tenth of the total area of the territory, where the plant occurs. That my estimation in this regard is upheld by others who have investigated the matter and expressed an unbiassed opinion is shown by the following lines, translated from an articie by DR. R. ENDLICH, in "Der Tropenpflanzer." The author says in part :—

"The supply of the Guayule is very unevenly distributed in the territory the plant occupies. In most places the plants are isolated, growing sometimes in large and often in small numbers among the other plants. At rare intervals small patches are found where it is predominating in the chaparral flora."

"It is very difficult to make an estimate of the average supply per hectare, both on account of the uneven distribution of the plant and because of the difference in size of individual specimens. In favourable territory I have on several occasions counted thirty to forty plants on an area of 100 square meters, which would mean a total supply of 3,000 to 4,000 Guayule plants per hectare (= 1,215 per acre). The differences in size and weight are so great that in places where the plants are small and grow close together ten plants have a weight of only one kilogram (= 2 1/5 lbs.), while in the best territories some of the trees weigh as much as 3 kilograms each. The average weight will probably not exceed 500 grams (1 1/10 lb.) per plant."

"Estimates of the Guayule supply in large areas vary from 500 to 800 kilograms per hectare, but the distance between the different places where the plants are found is often considerable, and must be taken into consideration."

The Guayule shrub is about two feet high, with knotted, spreading branches and sparse, greyish leaves. The whole plant contains rubber, with the exception of shoots bearing leaves and flowers. Consequently the whole plant is gathered and the supply is rapidly exhausted on the area, where gathering is done. Even the roots are in most cases pulled up by the collector, and the opportunity for re-growth is reduced to a minimum.

The rate of growth is very slow, so that a plant 20 inches high is three to four years old, while plants five years old are not more than 30 inches high. Such a plant would weigh about four pounds. In view of these facts it seems more than illusionary to speak of growing the Guayule plant for commercial purposes. Brought under domestication the plant could naturally be made to grow much faster, but there are still other factors to be taken into consideration. The dry country in which the Guayule plant grows, has a very scanty and irregular rainfall. For an agricultural crop that kind of land can hardly be expected to supply the necessary requirements, and the uncertainty about the germination of the seeds brings in such an element of chance, that indeed very much faith in Providence must be present to undertake the growing of Guayule without any provision for occasional artificial irrigation. The price paid has been as high as $43 per ton of dry plants, pressed into bales and delivered at railroad station. With that price, and the slow growth of the plant it is difficult to see how anyone can in earnest consider the cultivation of Guayule. Factories operating a large area should naturally take some steps for re-covering the ground with Guayule, but beyond sowing the seeds, and taking the chance of their germinating, and growing in a few years to a size, that can be utilized, it is hardly possible to do anything.

As for the fear of Guayule filling the market to the exclusion of crude rubber from previous sources of wild tropical rubber and from present and future plantations, such an idea is hardly worth refuting. If we remember that the requirements at present of the United States alone amount to more than 60,000,000 lbs. annually, a simple mathematical calculation, based on the most exaggerated expectations of the output of Guayule rubber from the entire territory where it is growing, will show the role this product could have in the world's market, even supposing that the supply was inexhaustible and as large as claimed by Guayule enthusiasts.

It may be added that the quality of Guayule rubber is very inferior, the rubber being very sticky and rapidly deteriorating. The market value is very low in comparison with that of first class rubbers, but it still leaves a wide margin for profit, and the supply of rubber plants is apparently enough for a few factories, not too closely situated. As a special product the Guayule has a market of its own, and if cultivation of this plant can be accomplished on a profitable basis, it will prove a great boon to the sterile parts of Northern Mexico.

Another rubber plant of Mexico, *Euphorbia elastica* has been spoken of. I have seen the plant, but have not been able to obtain a sample of the product, which I understand, however, somewhat resembles the Guayule rubber.

POSTSCRIPT.

I may have failed to convey a right idea of the extent of our Mexican rubber industry in my discussion on the previous pages. But I hope I have drawn the reader's attention to the fact that, although we may be far behind other countries in our methods, we are trying to do things as best we can. There has been much to bring our rubber planting industry into disrepute. But we are by no means downhearted, and we feel confident that we shall some day be able to do our share in contributing to supply the world with that valuable commodity, rubber. The area now planted will yet be largely increased in Mexico and all through Central America, but I do not think this need cause rubber planters, present or prospective, in other countries, any concern. There is plenty of room, and with more rubber produced we shall have more articles made from this staple for he benefit of mankind.

THE USE OF SEEDS FOR ORNAMENTAL PURPOSES.*

The use of ornamental seeds in the manufacture of household articles and for personal adornment is common in many countries, but in few perhaps has the application of natural forest seeds become an industry so definite as appears to be the case in Mazagon, Bombay. This is described in an article which appeared in the "Times of India" for July 13th, 1906, here reproduced.

This article is of interest to Kew as some time ago (May, 1905) Mr. G. M. Ryan, F. L. S. of the Indian Forest Service, presented to the Museum, on behalf of the Sisters of All Saints' School at Mazagon, a handsome screen, measuring 7 ft. by 5 ft. made up of 110 strings in the manner described.

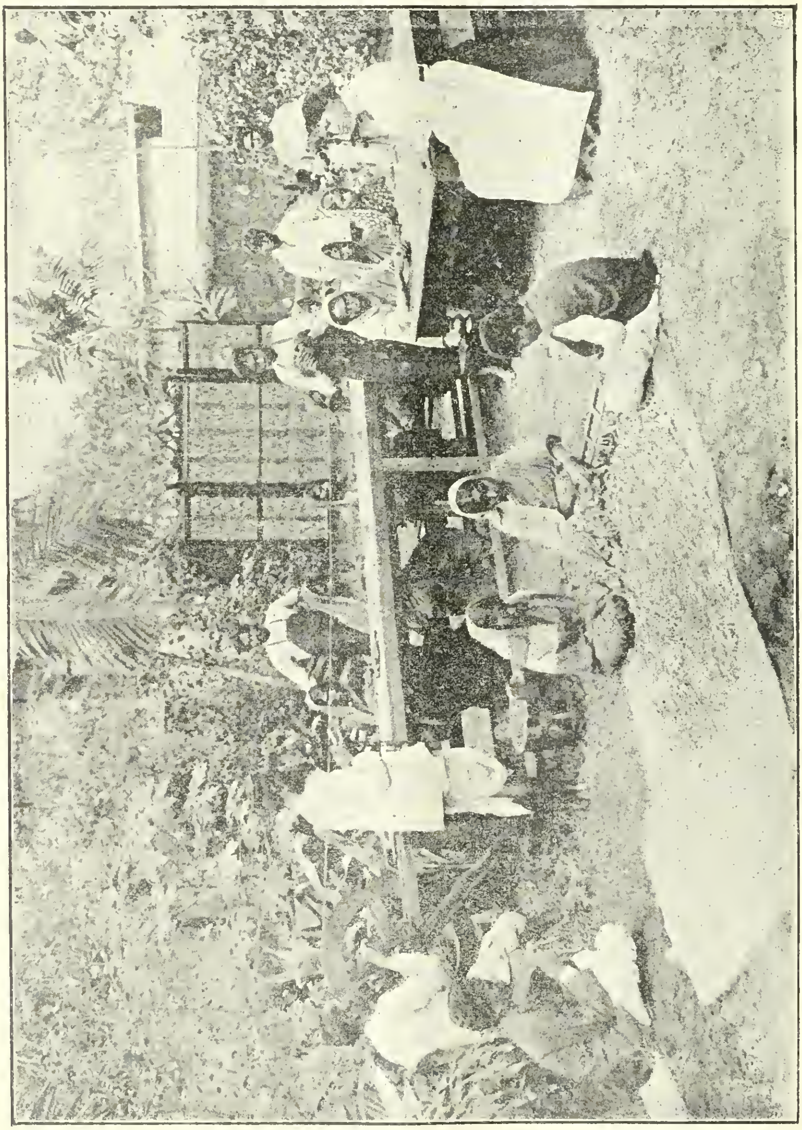
The seeds employed in this instance were "Job's Tears" (*Coix Lachryma-jobi* Linn.), "Red Wood," sometimes according to Dict. Econ. Prod. India, called "Red Sandal Wood" (*Adenanthera pavonina*, Linn.), seeds of *Mimusops Kauki*, Linn., and short pieces of what appear to be the peduncles of "Great Millet" (*Andropogon Sorghum*, Brot. var. *vulgaris* Hack.), or an allied form.

The photograph of which a reproduction is given here, illustrating the work in course of progress, was presented by Mr. Ryan with the screen.

"The Indian jungles are remarkable for the number of hard bright seeds of many colours that are found upon their trees and climbing plants. Every colour except probably light blue and bright green is represented, and these seeds, if gathered when quite ripe, are hard and durable, some being about the hardness of bone. In size they vary from that of a large watch downwards, and beyond occasional use for their real or supposed medicinal properties, they have been allowed to fall and rot where they grow, unless, like the myrabolan and mhowra, they possess some commercial value for industrial or economic purposes. The beauty of many of these seeds and their durability must have often suggested their use as ornaments as it did to Sir George Watt, Director of Economic Products to the Government of India, but the difficulty of piercing them regularly and cheaply seems to have stood in the way until Mr. J. Wallace, Editor of the "Indian Textile Journal" at Bombay, took the matter in hand. He had been keenly interested in Oriental industries for more than twenty years, and the utilization of forest seeds seemed to him to offer the nucleus for a minor industry that might take the place of needlework in certain schools as sewing is one of the worst paid occupations in the world. The drilling of the seeds was the first problem to be solved, and as they vary greatly in shape, appliances had to be devised that would hold them and at the same time guide the drill so that it might always pierce them in the desired manner. All the appliances had to be cheap, easily made, and repaired, and simple enough to be used by unskilled labour without undue wear. The

* From "Bulletin, Royal Botanic Gardens, Kew," No. 7, 1906. pp. 253-255. The block for the plate has been lent by the Director of Kew Gardens.

seeds were finally held in an instrument resembling a nut-cracker with conical recesses on the inner sides which held the seeds and a hole passing through the apex of the cone, which guided the drill. These "clamps" were made of hard Indian wood in various sizes, and were arranged for drilling single or double holes through the edge, or side, or for drilling long seeds lengthways with speed and accuracy. The steel of knitting needles, piano wire, and old bicycle spokes were found to be of excellent quality for drills, and they furnished a cheap supply of material which is easily converted.



"When the tools had been reduced to practical form the work was taken in hand by the Sisters of All Saints at their school in Mazagon, Bombay, with a capital of sixty rupees and an outfit of tools presented by their friend the Editor, who became chief artificer and inspector to the new industry. Seeds were contributed in small parcels by friends, and the artistic taste of the Sisters soon produced many charming devices, including certain loops for heavy and light curtains, necklaces, napkin-rings, hat-pins, buttons, bracelets, seed partieres and screens which found a ready sale at remunerative prices. Certain of the seeds, notably the rudraksha (*Elaeocarpus Ganitrus*, Roxb.), sacred to Shiva, were bleached and dyed in brilliant colours which added greatly to their value as buttons, beads, or hat-pins. This process taxed the talent of nearly every well-known chemist in India, who generously gave their assistance free. The rudraksha is a hard spherical nut with a very rugged surface divided normally by fine slits like the divisions of an orange, but it has many varieties both in shape, size, and number of slits, and to each of these varieties special virtues are ascribed. They protect the wearer against sickness and misfortune, procure success in life, and realise all the ambitions of the Hindu. Their value of course varies with the properties ascribed to them, and they are largely sold to pilgrims who visit Benares. When found they are usually very dirty, the interstices being filled with remnants of decayed fruit which adhere strongly, but after the various processes of cleansing, bleaching, dyeing, polishing, and mounting, a remarkable transformation has taken place with a proportionate increase in value. Many of the seeds only require polishing by friction, which brings out a lustre that was previously quite unexpected.

"The first outfit of tools was soon too small and additional drills were needed. The typical machine now consists of six small horizontal drill heads arranged along a narrow table which accommodates six drillers. The clamp holding the seeds rests upon a small adjustable bracket which supports it at the level of the drill point ; and power is applied by a coolie who turns a wooden wheel at the end of the table. A cord from this wheel makes a single turn around the small pulley of each drill and returns above them to the wheel. One labourer thus serves six drills without any complication of mechanism. The drill heads will, when required, carry wheels for grinding the drills. They will also carry a hook for laying up the silk cords used in embroidery and for making the woolen girdles worn by the Sisterhood. The demand for seeds soon outran the irregular contributions of friends and acquaintanances, but fortunately arrangements were soon made for a system of supply direct from the jungles. Space for a display of the work of the All Saints Sisters in the Forest Section of the recent Industrial and Agricultural Exhibition was also provided, where the industry gained a bronze medal and attracted much attention, their 'chicks' or partieres being conspicuous for their rich and harmonious colouring. Beads of special kinds have been introduced among the seeds with excellent effect, and although the number of seeds used is over 25, the list is far from complete and is constantly being added to. The resources of Burma, Ceylon, and many parts of India are still unexploited.

"The seed and bead industry is interesting for several reasons. It is based on the use of materials which were previously without value, and these materials are worked up with the aid of new tools and appliances designed expressly for them under very strict limitations as to cost and complication. The industry has become a commercial success in the hands of ladies who had no previous experience in the work, which seems to be especially adapted to the needs of industrial schools, as without being very difficult to learn, it requires enough of special knowledge to protect it against the competition of careless or unscrupulous rivals whose one object is cheapness, regardless of quality. At All Saints' Home quality of work and speed of production receive due attention, and as these essentials demand that all the tools and appliances shall be kept in good order, the training of the workers is of a kind that is but calculated to correct the national habit of carelessness among them.

"Seed and bead work should take a prominent place among the small industries of India, and should serve as a model for kindred undertakings in which simple appliances are needed to increase the efficiency and productiveness of the workers. Her Royal Highness the Princess of Wales when in Bombay recently paid a visit to the Industry and made several purchases. One of her purchases was a necklace which is now named after her."

BOARD OF AGRICULTURE.

Extracts from Proceedings.

The usual monthly meeting of the Board of Agriculture was held at Headquarter House on Wednesday, 23rd. October, at 2 o'clock p.m.; present—Hon. H. Clarence Bourne, in the Chair, the Director of Public Gardens, the Island Chemist, His Grace the Archbishop, the Superintending Inspector of Schools, Mr. D. Campbell and the Secretary. Apologies for absence were submitted on behalf of Mr. G. D. Murray, Mr. Conrad Watson, and Mr. E. W. Muirhead.

Representatives of Agricultural Society—The Secretary read letter from the Colonial Secretary's Office intimating that on the recommendation of the Board of Management of the Agricultural Society, the Governor had appointed Mr. E. W. Muirhead in room of Mr. Fursdon, resigned, and Mr. D. Campbell as the second representative.

Cotton Seed—The Secretary read letter from the Island Chemist stating that as a result of his examination of the cotton seed which had been treated with Corrosive Sublimate dip at Hope Gardens he was of the opinion that there was no evidence that the seed was damaged by the Corrosive Sublimate direct. It was very questionable to his mind whether the Imperial Department were wise in recommending the Corrosive treatment to planters as a routine procedure.

Rat Virus—The Secretary read letters from the Colonial Secretary's Office as follows :—(*a*) Intimating that the Governor had now approved of the Chemist's proposal for the establishment of a Rat Virus Service and for carrying out work for testing the varieties of Rat Virus in the market. The Chemist asked that the Secretary be instructed to write to the Governor to communicate again with the Mexican Government with regard to the Rat Virus they had offered, a previous sample of which had been received but which had become inert on the way.

(*b.*) *Milk Withe Experiments.*—Authorising the sum of £10 to be paid to Mr. W. B. Hannan to carry out experiments in getting rubber from the Milk Withe in Upper Clarendon, the amount to be charged under a new sub-head of the Government Laboratory on condition that a corresponding saving was made under the Chemist's vote.

(*c.*) *Vanilla*—The Secretary read letter from the Rev. John Maxwell reporting that he with Mr. Palache and Mr. Mennell had visited the districts of Mulgrave and Retirement in northern St. Elizabeth, to give instruction in Vanilla curing, and stating that they had been told that the vanilla in the woods bore pods without artificial fertilisation, and that he had sent a few cuttings to Mr. Fawcett to have a report made about it. Mr. Fawcett said the Vanilla sent was *Vanilla anaromatica*, not the Vanilla of commerce, *Vanilla planifolia.* Mr. Fawcett stated it was quite common to find the native species bearing pods and that even the commercial Vanilla had been fertilised by natural means at Hope Gardens and at Castleton.

Prickly Pear—The Secretary read letter from the Colonial Secretary's Office enclosing copy of letter from the Commissioner of the Turks and Caicos Islands with regard to the economic uses of Prickly Pear. The Secretary said this was being published in the Agricultural Journal.

Cotton Cultivation.—The Secretary read letter from Messrs. Kerr & Co., Montego Bay, to His Excellency the Governor, referred to the Board for consideration, stating that the firm had decided to do all they could to encourage the growing of cotton by the peasantry, and were prepared to erect a gin and buy all the cotton that was produced. First, however, some practical steps to teach the people how to cultivate cotton would require to be taken, preferably by practical demonstration, and if the Board of Agriculture or the Government could see its way to employ some one who had some agricultural knowledge to take up a few acres here and there in the most suitable districts in the parish they would be prepared to provide the funds for the cultivation.

The Secretary said that he thought the plan adopted by Mr. Arnett, Agricultural Instructor, if carried through on a larger scale would be a more successful way of encouraging small settlers to put in cotton than a central experiment ground. Mr. Arnett had received a £2 grant from the Agricultural Society and with this exceedingly small amount he had gone to the settlers in lower Trelawny and the seaboard of St. Ann who had places considered suitable, and asked them to cultivate a chain in Sea Island Cotton, he paying the expenses, and they were allowed to cultivate red beans and sometimes black-eye peas between the rows, getting all the plot produced. The settlers did not get much confidence from experiments carried out on what they thought fancy lines, but when they actually carried out the experiments themselves, they knew all the work and costs involved and they could appreciate the results. If some experiment could be carried out along the coastline of St. James under the advice and supervision of an Instructor such as Mr. Arnett who had already made himself familiar with such experiments, it would be the cheapest, most expeditious, and surest way of establishing cotton-growing amongst the settlers. Of course they could have larger experiments on estates besides, if wanted. In this connection the Archbishop asked what was being done to further the cotton growing industry ; they seemed to have made such a success of it in the other West India Islands and so little of it in Jamaica, that he was prompted to ask if everything was being done that could be done to further the industry.

The Secretary was asked to prepare a statement as to what had been done and what was being done as regards the Cotton Industry and circulate it amongst the members before the next Meeting.

Book on School Gardens—The Secretary read letter from Mr. J. R. Williams enclosing manuscript of book on School Gardens which, as he asked, had already been submitted to the Director of Public Gardens and the Island Chemist for revision, and expressing his appreciation to these gentlemen, to the Superintending Inspector of Schools, and Messrs. Cradwick and Palache, Agricultural Instructors, who had assisted him in preparing the matter.

The Secretary was directed to send Mr. Williams' letter to the Governor with the manuscript and to suggest that the book be published by the Government Printing Office, and be sold at the original price fixed : and to ask sanction for probable excess in printing owing to the enlargement of the book. The Secretary was also directed to express the thanks of the Board to Mr. Williams for the book which was likely to be of great value, and for the patient care and labour taken in preparing it.

School Gardens—The Secretary read letter from the Superintending Inspector of Schools referred from the Governor on the subject of School Gardens in St. Elizabeth, on which no action was taken.

West India Training School—The Secretary read letter from the West India Training School of Riversdale to Mr. Cradwick asking authority for a visit from him to advise as regards the new place they had established themselves on. He was authorised to call there if he could find the time.

Bath Agricultural Society—The Secretary read letter from the Bath Agricultural Society to him as Secretary of the Agricultural Society which he referred to the Board of Agriculture as it dealt with Mr. Briscoe's services. It asked that Mr. Briscoe should spend a fortnight on each occasion of his visit to the parish instead of three days, as his services were very much appreciated and were in demand. The Secretary said he had referred this to Mr. Briscoe who minuted that more time devoted to agricultural instruction in the parish was really needed than the few days he was able to give, but his present travelling allowance would not enable him to devote longer periods, if he still attended to other parts of St. Thomas and St. Andrew.

The Secretary was asked to see if Mr. Briscoe could arrange to give more time to the Bath district even if he had to reduce some of his services in other parts to enable this to be done.

The Chemist submitted his reports as follows :—

(1) Proposals for renewing the Laboratory Agricultural Course in January, 1908.

The Secretary was asked to send this on to the Governor and ask for authority to give the proposals effect.

(2) Soil surveys with Mr. Cradwick in St. Mary and Portland.

(3) Preparation of crop map of Jamaica.

(4) Legal standard for milk.

(5) Initiation of Rat Virus Service.

(6) Cocoa in St. Thomas.

No. 6 was read in connection with letter from the Bath Agricultural Society and the Board agreed that special efforts should be made to improve the cultivation of cocoa in St. Thomas.

Nos. 2, 3 and 4 were directed to be circulated.

The Secretary submitted reports from the Director of Public Gardens as follows :—

(1) Experiment Station.

(2) Instructors' Reports and Itineraries.

(3) Letter from Mr. Cradwick asking for authority to get a set of rubber tapping knives. This was authorised.

Papers which had been circulated and were now submitted for final consideration :—

1. Distillers Course for 1907.
2. Mr. Cradwick's Report.
3. Mr. Briscoe's Itinerary.
4. Report Experiment Station.
5. Secretary's Memo. re School Gardens which was read in connection with No. 7.

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BULLETIN

OF THE

DEPARTMENT OF AGRICULTURE.

Vol. V. DECEMBER, 1907. Part 12.

EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.,

Director of Public Gardens and Plantations.

CONTENTS:

PRICE—Threepence.

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1907.

JAMAICA.

BULLETIN

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PRESERVATION OF GRAIN FROM WEEVILS.*

At various times application has been made to Kew for advice in the preservation of grain from the attacks of weevils. As the method suggested in the following correspondence does not seem to be generally known, a selection of papers bearing upon the subject is published. It is obviously a matter of great importance in countries like India, where the grain production is liable to fluctuation from climatic causes from year to year. It may be added that the use of bisulphide of carbon has been found a most effective method of preserving specimens of seeds, &c., in the Kew Museums free from the depredations of insects.

MEMORANDUM by Prof. A. H. CHURCH, F.R.S., on the PRESERVATION AND DRYING OF GRAIN.

The only effective instrument for drying grain is that invented by Mr. W. A. Gibbs, of Gillwell Park, Chingford, Essex. It is called "Gibbs' Patent Tea Dryer," and is suitable for drying corn, coffee, manures, hops, brewers' grains, and fruit.

The only cheap and perfect application for the prevention of the attacks of weevils upon corn and grain consists in the employment of bisulphide of carbon.† The quantity required, provided the grain is kept in closed vessels, is very minute—not more than 1½ lbs. to each ton of grain—so that 1s. 6d. is the cost of preserving a ton. The bisulphide leaves no disagreeable taste or smell behind, and the quality of the grain remains unimpaired. When bags are used instead of the iron cylinders specially prepared for use in the bisulphide process, the protective influence of this chemical soon ceases, and a fresh application of the bisulphide must be made. In either case the liquid is applied as follows. A ball of tow is tied to a stick of such a length that it can just be plunged into the middle of the vessel containing the grain. The tow receives the charge of bisulphide like a sponge and is then *at once* plunged into the sack or cylinder and left there, the mouth being tightly closed. When

* Extract from *Bulletin of Miscellaneous Information*, R. Gardens, Kew. July, 1890.

† To be obtained from the Chemist, Govt. Laboratory, Kingston, P.O.,—5 lbs. in an iron drum for 5s. *Editor.*

necessary, the stick may be withdrawn and the charge (of 1 oz. bisulphide to 100 lbs. of corn) may be renewed.

(Signed) A. H. CHURCH.

A somewhat similar method was devised in Burma by Mr. Cabaniss: naphthalene being employed instead of bisulphide of carbon.

NOTE by MR. F. W. CABANISS, Assistant Director of Agriculture, Burma, on the PREVENTION AND DESTRUCTION OF BLACK WEEVIL IN GRAIN--BINS AND GODOWNS, dated the 5th November, 1886.

The black weevil is an insect well known to grain dealers, I suppose, the world over, and especially well known in tropical climates. In India it eats the grain of wheat and maize from the time it is reaped until it is in the hold of the ship, or made into bread and the bread eaten. It will even eat bread after it has been baked. It is most probably found in every rice, til, wheat, maize, and sorghum godown in Burma.

Like many other insects the black weevil seems to flourish particularly well in Burma. This is owing to the even temperature of the climate, as it dislikes the sudden changes to either heat or cold. It is impossible to estimate the amount of damage caused by this insect in Burma; but it is enormous. A large percentage of the shrinkage in stored grain can properly be attributed to destruction by this insect. It is not detected unless in very large numbers, but when the grain is cleaned by being passed through a fan, mill, or winnower, grain which has already been thoroughly cleaned will show a large amount of dust and a material falling off in the weight of the bulk or bin of grain. The natives try to combat the ravages of this insect by spreading the grain in the sun and then placing gunny cloth on the top of the grain, when the insect, disturbed by the heat of the sun, crawls out of the grain to the top of the cloth and is then shaken off, and the grain returned to the bin. This method of temporarily getting rid of the insect cannot be followed when there is a large amount of grain in store, on account of the expense of handling the grain.

I have been trying for several years a number of experiments with the object of finding a cheap and simple method of preventting the ravages of this weevil. I think that I have found it in the use of naphthalene powder. My method of using the powder is here given for the benefit of the grain dealers of Burma. It is best to place the naphthalene powder at the bottom of the bin or bulk of grain. To accomplish this, take a bamboo, about 1½ inches in diameter and long enough to reach from the top to the bottom of the bulk of grain. Punch the joints out of the bamboo, so as to be able to pass a stick through from one end of the bamboo to the other. Have the stick made to fit the cavity in the bamboo. Pass the bamboo, with the stick in it, down through the bulk of grain from the top to the bottom. Withdraw the stick, and drop into the top of the bamboo about half a teaspoon of naphthalene powder. The bamboo can then be drawn out, as the naphthalene is safe at the bottom of the bulk of grain. If the bulks are large this should be done once to every 10 feet square of the bulk. Repeat the application every 15 or 20 days as the powder evaporates.

The weevil that can leave the grain will do so, and those that cannot leave, are killed by the odour of the naphthalene. I do not believe that naphthalene thus used can cause any injury whatever to grain. For seed purposes the germinating powers appear not to be affected in the least. For marketable grain the colour is not affected, and the odour will leave in a short time if fresh naphthalene is not applied to it. The quantity of powder used is infinitely small in proportion to the quantity of grain, and the powder is entirely destroyed by evaporation, so that for food purposes the food is *nil*.

Naphthalene powder can be procured at the Medical Halls in Rangoon at Rs. 2. 8. 0 per ounce, and a few ounces of it will be sufficient for one season for any grain dealer in Burma.

P. W. CABANISS.

The Government of India in 1887 appears to have directed experiments to be made as to the efficiency of the method recommended by Professor Church. The following report appears to show that it is well adapted to meet the difficulty of India.

EXTRACTS from Annual Reports of the Experimental Farms at BHADGAON in KHA'NDESH. and HYDERABAD in SIND, for year ending 31st March, 1889.

In pursuance of Government Resolution No. 6093, dated 9th September, 1887, Revenue Department, experiments were made to test the efficacy of CS_2 as a preservative of grain from the attack of weevils, and upon which a separate report was submitted in August last. The observations were continued this year.

A summary of the results of the experiment is given below:—

(a) That soft varieties of grain, such as soft wheats and jowári, are sooner attacked with weevils than hard varieties, as bansi wheat, bájri, &c.

(b) The CS_2 is a perfect preservative against the attack of weevils upon grain.

(c) The action of CS_2 lasts in cases not hermetically closed six weeks, after which period a fresh charge of the re-agent is required.

(d) That even in samples which have been attacked with weevils the effect of CS_2 is immediately felt, the weevils disappearing *en masse*.

(e) That CS_2 does no harm to grain as regards its colour, smell, cooking properties, &c.

(f) That the poisonous property of CS_2 need in no way interfere with its introduction into Indian villages, as unlike arsenic, its strong and repugnant smell will act as a sufficient safeguard.

(g) With the dismantling of the old granary, which was used as a storehouse of grain for the last 19 years, weevils have almost disappeared from the farm. After a long and diligent search I succeeded in observing only a few under the heaps of jowári ears in the threshing yard so late as the 20th of last month. This proves beyond doubt that wheat is most damaged by weevils in city godowns, where a large quantity of it is stored every year before being shipped to Europe.

(h) It is, therefore, fair to conclude that painting the interior of the godowns with poisonous paints, and charging the grain with CS_2 (in proportions of $1\frac{1}{2}$ lbs. of the re-agent to a ton of grain) will reduce the damage caused by weevils to wheat and other grain to a considerable extent.

The following note is contributed by Mr. G. R. C. Heale, Knockalva, Sept., 1907.

"In South Africa, where the farmers depend chiefly on their corn or "mealie" crops, corn is preserved in air-tight tanks which, having been filled almost to the top, have whatever little air remains in the tank exhausted by means of a small candle which is placed on the corn and lighted. The tank is then covered and hermetically sealed. I have been told that corn preserved in this way will keep for years. The expense is rendered worth while as it frequently happens that practically all the crops in the country have failed on account of hail-storms and swarms of locusts."

CAMPHOR IN CEYLON. III.

By M. KELWAY BAMBER.*

A considerable amount of attention has been given to this subject lately owing to the high price of camphor now ruling, and before discussing the method of growth and cultivation, it will be as well to briefly outline what has already been done in Ceylon, with a view to its introduction as a new minor product. During the year 1895, Mr. Nock, late Superintendent of the Hakgala Gardens, brought the matter to the notice of planters in various parts of the Island at elevations ranging from 2,500 to 6,450 feet, and under all conditions of climate and rainfall, and distributed about 1,000 plants raised from Japanese seed. These were planted out chiefly along roadsides between tea bushes, and apparently in most cases received little or no special attention. About 1900, reports from the various estates were obtained, which proved that under suitable conditions of soil and climate camphor would thrive at most elevations from about sea level to over 6,000 feet. It was found that a deep, well-drained sandy loam in sheltered situations answered best, the growth in such cases being fairly rapid, the trees reaching 18 to 20 feet or more in five years, with a spread of 8 to 12 feet or more and a stem 6 to 7 inches in diameter, this comparing favourably with the growth in their native habitat in hillsides and in valleys in China, Japan and Formosa. Mr. Nock, in a paper on the subject in 1900, points out that the best 5-year-old tree was growing at Veyangoda at

* From Agricultural Bulletin of the Straits and F. Malay States. V. 5. May, 1906. p. 162.

100 feet elevation, and where the rainfall was 100 inches falling on about 180 days, the height of the tree was 25 feet with corresponding girth ; the next best was a tree at Hakgala 20 feet high, with a spread of 13 feet and a stem girth of 24 inches. In 1898 experimental distillation of camphor from the leaves, shoots, and wood were made by Mr. S. A. Owen, of Lindula, and Mr. Nock at Hakgala, with somewhat variable results in some cases no camphor being obtainable, although the atmosphere around the stills was full of the pungent smell, while in another case Mr. Owen obtained camphor at the rate of 15lbs. per ton of prunings or 0·67 per cent.

In May, 1900, Dr. Willis arranged for a series of distillations, to be conducted by myself in Colombo, and prunings of camphor from Hakgala and other districts were experimented with under varying conditions, the results of which were published in a circular issued by the Royal Botanic Gardens in November, 1901*

On an average about one per cent. camphor and some oil was obtained, but the results were not always satisfactory owing to some cause not clearly understood at the time. During the last 12 months further experimental distillations have been made, with the result, in one instance, that about 2 per cent. of camphor, with a small quantity of oil, was obtained, while on the average the yield amounted to 1·5 per cent. on the fresh prunings and it is upon this basis that estimates may now fairly be made. The yield is somewhat lower than that from twigs of old trees in Japan, which give 2 21 per cent. and much lower than the average from the whole tree, *viz.*, 4·22 per cent.

From these experiments the cause of the comparatively low yields previously obtained was discovered, and in practice it should now be possible to secure the camphor without loss. Another detailed circular will shortly be issued on the subject by the R. Botanic Gardens, Ceylon; but meanwhile I propose to briefly describe the method of planting and the precaution necessary in the distillation, if successful results are to be obtained.

THE SEED FROM JAPAN.

Up to the present camphor has been raised almost entirely from seed from Japan, plants from cuttings not being readily raised in Ceylon.

The seed is round, black, and the size of a vetch or sweet pea about 7,000 going to a pound. The germination is frequently very irregular, but seed obtained in November should have a germination of 50 to 60 per cent. ; though in some cases hardly a plant has been obtained from several pounds.

The seeds should be sown as soon as possible after receipt, first soaking them in water for 24 or 48 hours, and separating the

* Reprinted in Bulletin of the Department of Agriculture, Jamaica, IV. 6, June 1906, p. 129.

heavier ones from those that float. The beds should be carefully prepared and protected from insects and vermin, as the seeds are very liable to be eaten. The soil should be a free sandy loam, with a good proportion of leaf mould, and well drained. The seed may also be germinated in pure sand or waste fibre and any care given at this stage would be well repaid.

It should be sown about three quarters of an inch deep, and the beds well shaded to preserve an even degree of moisture, which is essential for germination.

The seedlings should, when 3 to 4 inches high, be pricked out into well-prepared soil in supply baskets (or bamboo pots) and kept shaded and watered until they begin to grow; when the shade can be gradually removed to accustom them to the full sun.

When 9 to 15 inches high they are at their best for planting out, but may remain in the nursery until 2 feet or more if the weather is not suitable. It is needless to point out the necessity of waiting for suitable planting-weather rather than run the risk of losing them altogether, but, if dry weather should occur after planting out, thickly mulching the soil round the plant with any available organic matter will do almost as well as watering to keep them going until the rains fall. Mr. Nock has tried making cuttings from suitable branches, but not very successfully, as if too dry they soon shrivel up, and too wet and cold they decay before the roots are formed. These attempts were made at Hakgala, and possibly better success would be obtained at lower elevations and in a warmer climate. Here again waste coconut fibre might be tried, as it would be a great advantage to obtain plants by this means.

The best material for cuttings is that from straight, healthy, and well-matured shoots of the current year's growth, about $\frac{1}{4}$ to $\frac{3}{4}$ inch in thickness and 6 to 9 inches long. The cuts should be clean and just below a joint to form the base of the cutting, this being a point of great importance.

The beds for cuttings should be similar to those for seeds, and may have a layer of charcoal and sharp sand an inch thick on the surface.

To insert the cuttings an opening is made with a spade, the cutting put in, and the spade withdrawn, allowing the earth to fall back into its place and then pressing it firmly down. They should be planted as soon after removal from the tree as possible, and the beds well shaded, gradually allowing them sunlight as they become rooted, which takes place from 2 to 3 months.

Camphor may also be propagated by layers, where the branches are low enough for the purpose; and this will probably be found one of the best means of obtaining good plants and possibly of selection for yield. The branches should be bent down, laid in a trench in the soil after being cut or twisted to break some of the fibres and encourage root development, then covered with soil, small pegs being inserted to keep them in position.

A SUSCEPTIBLE TREE.

In planting out care should be taken to see the holes are large and deep, and the soil well loosened at the bottom, and surface soil should be used for filling them up. From the present growth on various estates it is evident that the tree is very susceptible to its surroundings, as it is rare to see 3 or 4 trees planted together of uniform appearance. This may, of course, be due to differences in the vigour of the seedlings, but it is more probably owing to physical variations of the soil in which it is planted. The difference in growth and vigour is sometimes so great that a small area of the prunings obtained from the same aged trees have varied from over 100 lbs. to about 8 lbs. per tree, the latter amount being quite unprofitable. The importance of a careful selection of soil and situation is, therefore, most apparent. As regards the latter, the trees will not stand exposure to rough winds, so that more or less protection during the S.W. monsoon is essential for luxuriant growth. Probably 8 by 8 feet would be the best distance for planting, and the trees are to be kept in the form of bushes, and this distance would give about 680 bushes per acre.

They can be planted amongst tea with little risk of harming the latter in the factory, as an experiment has shown that a high proportion of camphor leaf, mixed with the tea leaf, was not detected in the finished article, the quantity added being far more than could possibly occur accidentally.

In poor tea-soil the growth is very slow, and much better results will be obtained by planting in virgin soil ; the amount of such soil available is, however, limited, which from one point of view may be considered a decided advantage, as the supply of camphor can easily be overdone, unless new uses for it are discovered.

As stated before, camphor has been tried at all elevations, and on all kinds of soil with very variable results. Although the finest tree was grown at Veyangoda, it was generally at high elevations (above 4,000 feet) that the best results were obtained. At Peradeniya, 1,600 feet, the growth was only medium, and the trees never had a very healthy or vigorous appearance, while the percentage of camphor was also somewhat lower. These trees have recently been cut down, and are to be manured experimentally to determine the effect on the growth and camphor contents.

Some patna soils, notably those in Nuwara Eliya, have suited the tree admirably, but on others, poorer in organic matter, the growth is wretched even after five years and could only result in loss if planted on a large scale.

Under suitable conditions of soil, climate and exposure the growth should be sufficiently good to yield one or two prunings in the third year, the best method being to clip the bushes all over evenly with ordinary shears, taking shoots of 6 inches to 10 inches in length. These should be collected without loss of leaf, tied in bundles and taken directly to the still.

DISTILLATION.

The still required for the purpose is of the simplest description, and very similar to that used by the Japanese in Formosa, with slight improvements in the condensers, as perfect condensation is absolutely essential for success. The slightest smell of escaping camphor may mean a loss of 20 per cent. or more, as has been proved by several experiments, and the two means of preventing it and obtaining the maximum proportion of camphor to oil are absolute condensation and *slow* distillation with a minimum of heat.

The still may consist of an ordinary wooden cask, but is better if somewhat conical in shape, and should be about 6 feet high, feet diameter at the bottom and 2 feet 6 inches at the top ; and have a close fitting door at the lower end for the removal of the refuse prunings. The top or a portion of it must be removable, but capable of being hermetically closed. From near the top a large diameter bamboo 5 to 7 feet long passes to the condensing boxes of wood placed in a suitable tank and connected with short lengths of similar bamboo. The still has a perforated bottom and stands over an iron basin built into a small stone or brick furnace. The basin about 2 feet 6 inches to 3 feet in diameter is filled with a supply tube for adding water as required and an overflow pipe closed with a plug during distillations. The condensing boxes consist of bottomless boxes of suitable size, having 3 or more partitions in each with communications at opposite ends of each division to insure thorough circulation of the camphor and water vapours. The tops of the boxes are hermetically closed about one inch below the upper edges, and the boxes are stood in the tank as mentioned above, being connected by short bamboo lengths. Cold water from a stream flows from a pipe or bamboo on the top of each box and then over-flows into the tank, which has an outlet pipe 2 to 3 inches from the bottom. By this means a water seal 3 inches deep is kept round the bottom of the boxes. The mixture of camphor, vapour and steam from the still enters the first box just above the water level, circulates round the various partitions, and so passes from box to box, the camphor being condensed in pure white crystals on the walls and partitions as it cools down. The last box is filled with an outlet of bamboo, which can be kept closely plugged with straw. This acts as a safety valve, and enables one to ascertain whether condensation is perfect, as there should be little or no smell of camphor observable. In working, the still is loosely filled with the fresh prunings as brought in, the top put on and well luted with clay, water poured into the basin, and a fire lit to bring it rapidly to the boil. As soon as this occurs and a slight smell of camphor or eucalyptus can be smelt at the escape tube on the last box, the fire is reduced and the water merely kept *hot* for several hours. A good plan is to have a glass let into the cover of the first, (or all) of the condensing boxes and as soon as vapour begins to condense on it, to im mediately reduce the fire to a minimum, as the object to be gained is to drive off *all* the camphor with as little steam as possible. A small wooden spigot in the top of the still makes it possible to ascertain when all smell of camphor has disappeared, but care must be taken when opening it not to become scalded. When completed, probably in 3 to 4 hours the door at the bottom of the still is opened, the prunings removed and the still recharged from the top. All water in the pan, which contains much tannin, &c., in solution, is changed by opening the overflow plug and pouring in a fresh quantity through the supply tube. During distillation it is necessary to occasionally add some water to the pan to maintain a constant level and prevent burning. To save time it would be best to have two stills connected with the condensers, as with many citronella grass stills, since the one could be filled, while the other distillation was proceeding; the latter could then be allowed to cool down before opening, without a loss of time. To preserve the heat in the top of the still and ensure the camphor passing away readily, the still should be thickly coated with clay or other non-conducting material, the Japanese method being to surround the still with cane work and ram clay into the space between.

When a condenser is seen to contain sufficient camphor, it should be opened, and the camphor carefully scraped out, every precaution being taken to keep it free from dirt or fragments of any description, otherwise re-distillation would be necessary if the best price is to be obtained. A wooden scraper should be used, contact with metal being avoided as far as possible while in the moist condition.

The camphor should be placed in a well made box like a tea chest, having a perforated false bottom 4 or 5 inches from the actual bottom, and the top perfectly closed. In a few days most of the oil will have drained into the lower portion of the box, which should be zinc-lined, and the dry camphor can be removed, and carefully packed in zinc-lined cases for despatch.

By reducing the camphor oil to a low temperature fully 50 to 60 per cent. of solid camphor separates out, and can be removed with a cloth strainer and well drained, the temperature being kept as low as possible while the excess of oil is draining away.

Should any of the camphor be accidentally discoloured, it should be thrown back into the still with a subsequent charge of prunings for re-distillation.

The question of purification by sublimation with distillation of the oil for the production of safrol, white oil, and other products will be fully gone into in the circular previously referred to, and need not be discussed here. The chief uses of camphor are for the manufacture of celluloid, smokeless explosives, fireworks, &c., and medicinally in the treatment of influenza, dysentery and cholera. For the latter disease, it was used most successfully in Naples in 1854, all the cases treated recovering, and it was employed with equal success in Liverpool in 1866. Any outbreak of influenza increases consumption at once, but the chief demand is for the manufacture of smokeless powders and celluloids; it is also said to be employed in one of the numerous rubber substitutes now manufactured.

THE PRICE OF CAMPHOR ; AND THE WORLD'S CONSUMPTION.

In 1895 the price of camphor was £8 to £9 per case of one cwt., but during the Chino-Japanese war it reached £20 per cwt., the price at which it apparently stands to-day. This high price may be due to a temporary shortage or to a corner in camphor, and it would be risky to base any estimates on the present inflated prices.

The total world's consumption probably does not exceed 6,000,000 to 7,000,000 lbs., which amount can be produced by Japan and Formosa, though possibly it is becoming more and more difficult in the former country from partial destruction of the trees, and in the latter owing to the dangers of collection.

Taking a medium estimate of what can be obtained in Ceylon, the planting up of 15,000 to 20,000 acres would supply the above amount, so that the price would rapidly fall and the cultivation grow more or less unremunerative, although the trees would always be a valuable asset in the case of a sudden demand, and would yearly increase in value.

It was also stated in 1903 that a limited Company had been formed in New York for the production of camphor by synthesis with a share capital of $1,000,000 and with plant for an annual output of 2,000,000 lbs., the annual amount required by the United States. The crude material employed in the manufacture is turpentine oil, and the yield is said to be 98 lbs. of camphor from one barrel (136 gallons) of the oil. At the figures quoted, the cost of production might be anything from 10d. to 1s. 4d. per lb., while the cost of production in Ceylon would be considerably below this. The leading camphor consuming countries are :—

Germany	...	2,000,000 to 3,000,000 lb.
United States	...	2,000,000 lb.
England	...	1,000,000 to 1,500,000 lb.
France	...	1,200,000 lb.
India	...	1,000,000 lb.

In estimating the probable yield per acre, it would, I think, be better to calculate on only two prunings a year, *i.e.*. after the two best growing periods, *viz.*, March to May and October to November. During the third year well-grown bushes should then give about 50 to 60 lb. of prunings each, which would give a handsome profit even if present prices were considerably reduced. While it is probable that camphor will be a valuable adjunct as a minor product in many upcountry and other places where Para rubber cannot be grown, it is as well to bear in mind that the demand is somewhat limited, and that India and other countries have also turned their attention to this product during recent years.

For articles on camphor in previous Jamaica Bulletins, see B. of Bot. Dept., N.S.,I. Oct., Dec. 1894, p. 170; Do. VI. 12, Dec. 1899, p. 177; B. of Dept. of Agri., IV. 6, June 1906, p. 129; Do. IV. 8, Aug. 1906, p. 177, Do. IV. 10, Oct. 1906, p. 232.

LEMON GRASS OIL.*

A product for which there is at present a good demand in the London market, late quotations being from 8¼d. to 8½d., is the oil of lemon grass. The value of the product has steadily increased from a trifle over 40 rupees to 58 rupees per gallon, and is likely to rise higher in the near future.

Lemon grass luxuriates in a well-drained sandy soil but has been known to thrive also upon laterite provided the dry weather be not prolonged. It is also a lover of moisture in the soil but is unable to withstand water-logging. For the highest purposes of its cultivation, however, the most suitable soil is an arenaceous clay and the best climate one which presents a distinct alternations of sunshine and shower.

The crop will, under ordinary conditions, be ready for harvesting in the cold weather of the third year from planting it out. On cropping the grass it is committed to the still with as little delay as possible. The usual method adopted with the grass is aqueous distillation in copper stills. In plantation-grown grass at least two crops can be harvested in the season, so that, calculating on an average on a bundle of the grass (of six inches diameter) from each of the 5,000 clumps which may safely be counted upon to attain to maturity out of the 7,260 planted out, the yield of an acre may be estimated at 10,000 bundles. Fifty such bundles yield a quart (40 fluid ounces) of the oil, so that the 10,000 bundles would yield 200 quarts or 8,000 ounces. Valued at 8d. per ounce, which is the current average selling price of the oil in the London market, the produce of an acre would realise £269 13s. 4d. Even should the crop cost £69 13s. 4d. to raise, tend, harvest, distill and transport the oil to market, a profit of £200 per acre would be obtainable from it from and after the cold weather of the third year of its establishment. For previous articles, see Bulletin, March (p. 53) and Dec. (p. 275) 1903; Oct. (p. 224) 1004; May (p. 102) 1906.

MEXICAN BROMELIA FIBRE.†

Among the collections of fibres from tropical America shown at exhibitions has frequently appeared a long silky vegetable fibre of a greenish colour, and showing great strength, though only an expert might particularly notice the small hanks into which the fibre is made up. When a specimen is unwrapped, however, the fineness of the fibre and its extraordinary length become apparent, for six feet is a common length. So long is the fibre that it is difficult to break even a few filaments by direct strain without cutting into the hands. According to the Bureau of the American Republics, this is produced from the long narrow leaves of a "wild pine" belonging to the genus Bromelia. The nomenclature of the species is confused, however, for the fibre has been variously

* From "Agricultural Bulletin of the Straits and Federated Malay States" August, 1906, pp. 282-283.

† From "Journal of the Society of Arts," No. 2854, Vol. LV., Aug. 2, 1907.

labelled in the museums and at exhibitions *Bromelia sylvestris, Bromelia pita, Bromelia pinguin, Bromelia Karatas*, and *Karatas Plumieri*. Its most common names are pita, pinuella, pinguin, and silk grass, though "pita" is meaningless, and silk grass is applied to so many other fibres that the name is worthless. The better names are pinuella and karatas. In the regions of Southern Mexico, from Oaxaca to Vera Cruz, where the plant grows in great profusion, the fibre is used largely for fine woven textures, where strength and durability are essentials, such as hunting bags and other forms of pouches. It is also used for sewing threads, and was formerly employed for sewing shoes. The fibre is cleaned by hand, and the great length of the thin narrow leaf, which is armed along its edges with sharp spines, makes it a tedious operation, hence the high price of the fibre. Efforts are being made to clean the leaves of the wild pineapple by machinery, and some fair examples of the fibre have been turned out experimentally in small quantities, so that future experiments are looked forward to with interest. The difficulty in the way of machinery extraction, is largely due to the fineness and length of the leaf, a machine powerful enough to scrape off the hard epidermis enclosing the fibre layer being too harsh in its action, thus injuring the fibre. The production of well cleaned, unbroken fibre by machinery, and in commercial quantities, would no doubt give to manufacturers a new textile which might enter into some of the present uses of flax, while the peculiar silkiness, and the colour of the fibre, would adapt it to the manufacture of many beautiful woven articles, such as fancy bags, and even belts for summer wear. It would doubtless make superior fishing lines, and with further preparation and bleaching, it is probable that the fibre might be employed in a wide range of woven fabrics of great beauty. An Italian authority states that in Brazil and Guiana, where a similar (if not the same) plant abounds, the fine silk fibre is manufactured into many *articles de luxe*. In an old work on Mexico a species of Bromelia is referred to, which is said to yield a very fine fibre six to eight feet long, "and from its fineness and toughness, it is said to be commonly used in belt-making work. It also finds application in the manufacture of many articles, such as bagging, waggon sheets, carpets, &c., besides being a valuable material for making nets, hammocks, cordage and many other articles in common use." This undoubtedly refers to the common form of Bromelia. A species of short-leaved Bromelia grows in Paraguay and Argentina, producing a somewhat similar fibre, which is known as Caraguata, the product of *Bromelia argentina*. The filaments from this species are rarely longer than four feet, and while the fibre is short and strong, it does not compare with the pinuella fibre from the regions of Oaxaco, Mexico. Bromelia fibre is closely allied to the famous pina, or pineapple fibre of the Philippines, from which are manufactured beautiful textures, such as fabrics for ball dresses. and handkerchiefs of gossamer fineness. There is said to be little doubt that with a careful preparation, some of the wild pineapple fibre might be employed in the same manner.

NEW SOIL STUDIES.*

It is a curious fact that, while the relation of the plant to the soil in which it grows is one of the most important among the environmental relations of the organism, yet plant physiologists and ecologists have so far paid almost no attention to the details of the nature and behaviour of the soil solution. This is perhaps due to the extreme difficulty of the problems involved, but they are seemingly no more difficult than the problems of absorption, photosynthesis, &c., with which botanists have successfully grappled. The work so far accomplished has been done almost entirely by students of agriculture who are not primarily interested in the science of botany but in its applications.

For some years the members of the laboratory staff of the Bureau of Soils of the U. S. Department of Agriculture have been following this line of enquiry in a truly research spirit, and have brought out a number of valuable contributions. In Bulletin No. 41 of that Bureau, Frank K Cameron and James M. Bell present the results of a study of "The Action of Water and Aqueous Solutions upon Soil Phosphates." The discussion lies mostly in the realm of physical chemistry, as must naturally be the case, but direct application of the facts brought out is made to the theory of fertilizer practice in agriculture. "The phosphates of the soil * * * are of such a nature as to yield a solution containing very small quantities of phosphoric acid. * * * The least soluble phosphates are the ones which will be formed and will control the concentration of the soil moisture. This fact, together with the well known phenomena of absorption, gives a satisfactory explanation of the observation that the concentration of the soil moisture is low and varies but little for different soils and with the total amount of phosphoric acid in the soils. For the same reason, the addition of phosphatic fertilizers can not be expected to influence materially the concentration of phosphoric acid in the soil moisture. The action of phosphatic fertilizers is, therefore, on the soil and not primarily on the plant; for the concentration in plant food constituents of the solution on which the plant feeds is not materially altered by the addition of phosphatic fertilizers in the amounts used in ordinary field practice."

B.E.L.

Few scientific theories have stood the test of time and experiment so long and gained such universal acceptance as the Liebig theory of soil fertility. Nevertheless, recent investigations seem to indicate that this conception is likely to undergo considerable modification in the near future, suggesting that the "exhaustion" of many soils may be due, not so much to the withdrawal of mineral constituents as to the accumulation of certain organic toxic substances. This idea is not a new one, for as long ago as 1832 DeCandolle stated that many plants give off in their growth substances which are injurious to themselves and to closely

* From "The Plant World," Vol. 10, No. 9, September, 1907, pp. 209-213.

related plants, but harmless to others. This conception, based on insufficient evidence, as it was, did not gain acceptance, but has smouldered along in agricultural science ever since, flickering up occasionally only to be smothered for lack of experimental proof.

During the last few years, however, a great deal of new evidence has been presented in favour of DeCandolle's idea. In 1897, and subsequently, investigations at the Woburn Experimental Fruit Farm, in England, have shown that the presence of grass in the soil about apple trees has a marked deleterious effect upon the growth of the trees. It was shown experimentally that this effect could not be due to the removal of nutriment materials nor of water, nor to the exclusion of air, and it was suggested that it must be caused by poisonous bodies emanating from the grass roots. A similar antagonism has been shown to exist between butternut trees and cinquefoil, and between peach trees and several herbaceous plants. In 1904, Livingston published evidence to the effect that bog water exhibits properties of a toxic nature and suggested that the xerophilous character of bog plants may be due to these properties.

For our knowledge of the presence of toxic substances in agricultural soils we are largely indebted to the work of the U. S. Bureau of Soils. In Bulletin 23 of this bureau, it was shown that the unproductiveness of certain soils examined could not be attributed to any lack of available mineral matter, and that the injurious properties of the soil could be transmitted to its aqueous extract, independent of the salt content. In later publications from the same bureau, evidence was presented in favour of the idea that certain poor soils contain toxic substances which act to retard the growth of roots. Further evidence favoured the conclusion that wheat roots give off substances toxic to themselves, and that this toxicity, as well as that of the soils mentioned above, can be removed from nutrient solutions or soil extracts by the absorbent action of carbon black, ferric hydrate, and other finely divided inert solids. In Bulletin 28 it was shown that when a nutrient solution becomes "exhausted," so that plants grow but poorly in it, it is greatly improved by treatment with carbon black, &c., the suggested explanation being that the roots first grown in the solution gave off substances injurious to themselves, and that these substances were removed by the absorbing action of the finely divided solids.

Two recent bulletins (Nos. 36 and 40) from the Bureau of Soils have contributed more information on this subject. In Bulletin 36, Livingston and others give more evidence in favour of the existence of toxic bodies in unproductive soils and add certain points as to the nature and origin of such substances. The conclusion is that toxic material is present in certain unproductive soils, either in very minute quantities or in a very slightly soluble form; that this material is volatile in some cases and in others non-volatile; that it is often destroyed by boiling the soil extract in which it occurs; that it is often accompanied by an acid reaction of the extract, but that in such cases the toxicity is not due to the acidity as such; that it is probably organic in its nature; and that it is absorbed by finely divided solids. As to the origin of such material, it is shown that toxic properties appear not only in nutrient solutions in which wheat is growing, but also in pure sand when this is used as a medium for growth. Similar substances appear to diffuse from soaking wheat seeds, and a similar toxicity is exhibited by the washings from the leaves and bark of certain trees.

In Bulletin 40, Schreiner and Reed show that agar-agar, in which the roots of wheat have been allowed to grow, soon becomes injurious to these roots. Agar-agar in which maize roots have grown is injurious to wheat, but not to so marked a degree as that rendered injurious by the growth of wheat itself. In pointing out the logical conclusion that the physiological action of the used agar-agar must be due to excretion from the first crop of roots, the authors call attention to the analogy between this supposed excretion by roots and the well-known excretion of toxic substances by bacteria.

The importance of all this to scientific agriculture is evident and the changes that these considerations may bring about in the theory of soil fertility may be very profound. The beneficial effects of crop rotation may be explained equally well from the standpoint of the Liebig theory or of this newer one, and this may explain why the phenomena of toxic excretions have so long escaped serious consideration. It appears that the Liebig theory has been pushed rather farther than necessary, but how far it is to to be supplemented or replaced by the new conception is at present only a matter of conjecture. There are enthusiasts on both sides of the argument.

W. B. McC.

STUDIES ON RATE OF GROWTH IN THE MOUNTAIN FORESTS OF JAMAICA.*

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While in residence at the Tropical Station of the New York Botanical Garden at Cinchona, Jamaica, during the winter of 1905–06, I was engaged in making a study of the physiological plant-geography of the Blue Mountain region above the altitude of 1375 metres. I have in preparation a paper embodying my results as a whole, from which I wish to give here an abstract of the portion relating to the rate of growth in native trees and shrubs as measured in their natural habitats.

The montane rain-forest which clothes the windward slopes of the Blue Mountains in the neighbourhood of Cinchona at about

* From The Johns Hopkins University Circular, No. 3, pp. 31–37.

† This investigation was carried on while the writer held the Bruce Fellowship of this University.

1525 metres altitude combines temperature and tropical features of physiognomy, and possesses a flora in which are mingled tropical and temperate genera and families. The foliage of the forest trees is rather xerophilous, but beneath its shade grow broad-leaved shrubs and herbaceous plants, tree-ferns, filmy ferns and multitudes of epiphytic ferns, mosses and liverworts,—in short a constellation of pronouncedly hygrophilous plants. The climate of the region is characterised by constancy of temperature, a heavy rainfall, well distributed through the year but heaviest in May and in the autumn months, by a high percentage of cloudiness and fog, and by high humidity. In the absence of climatic data for the windward slopes of the Blue Mountains the following figures for Cinchona, situated on the leeward side, may be taken as some criterion of the conditions in the former region, although the rainfall and humidity are too low and the temperature slightly too high, as I have learned by comparison of the records for Cinchona with thermograph and hydrograph records which I have obtained in the rain forest over the same shorter periods of time.

PRINCIPAL ELEMENTS OF THE CLIMATE OF CINCHONA.

	Temperature.	Rainfall.	Number of rainy days.	Humidity.
Jan.	58·8°F.	7·26 in.	14·1	84·1%
Feb.	58·3	4·09	12·5	83·1
Mar.	58·6	5·32	12·8	83·9
Apr.	59·3	6·36	12·9	83·4
May	61·0	11·10	18·1	85·2
June	62·3	8·00	13·5	84·8
July	63·1	3·89	10·8	79·6
Aug.	63·6	8.29	11·2	80·4
Sept.	62.9	9·22	16·1	84·4
Oct.	61·8	18·57	21·4	88·9
Nov.	61·0	12·32	18·3	86·0
Dec.	59·4	11·11	16·2	86·3
Means & Totals	60·8	104·77	179·4	84·1

The climatic conditions are quite favourable for growth and reproduction throughout the year, as indicated by the above data. During the seven months of my residence at Cinchona I made continuous observations of the growth, leafing-out, leaf-fall and flowering of the native trees. There were found to be wide differences between the periodicity of these phenomena in different species. In very many of them growth, leafing-out and leaf-fall are going on continuously. In others these phenomena are restricted to a period of two or three months, usually February, March and April. A few trees of north temperate relationship are completely deciduous. The time of flowering is variously related to the time of the growth and leaf formation, being the spring in many trees, the autumn in an almost equal number.

Our conceptions of the rate of growth in the tropics have been formed from observations made in tropical lowlands on such manifestly rapid-growing plants as the banana, the bamboo, Dendrocalamus, *Amherstia nobilis* and some other trees ;* such high rates as 231 mm. per day having been observed in stems of Dendrocalamus, and 107 mm. per day in leaves of the banana.

Owing to the slowness of the elongation of shoots the following observations have been made only upon growth of leaves. The individual plants upon which measurements were made were all located near Morce's Gap at 1525 m. altitude on the windward slope of the Blue Mountains. Plants were selected with a view to securing such as were growing under average light conditions for the species, and the leaves selected were those unfolding at the ends of shoots which were neither the most nor the least advantageously situated upon the plant.

Boehmeria caudata Sw. (Urticaceae). This is a large shrub or a small tree with leaves of thin texture, 20 to 30 cm. long by 10 to 20 cm. wide and opposite in insertion. Boehmeria grows continuously through the year, and its leaves fall continuously, being from five to seven months old at fall. The following figures give in millimetres the length and width of the laminas of two paired leaves, and the rate of growth in length per day.

Date.	A. Size.	Rate.	B. Size.	Rate.
Feb. 20	24 x —	—	26 x —	—
Mar. 5	54 x 31	2·30	49 x 26	1·77
Mar. 20	112 x 68	3·86	115 x 64	4·40
Apr. 2	139 x 89	2·07	145 x 92	2.30
Apr. 18	148 x 94	·56	170 x 104	1·56
May 11	150 x 96	—	175 x 190	—

Alchornea latifolia, Sw. (Euphorbiaceae.) This is a common forest tree with rather xerophilous leaves 15 to 20 cm. long by 6 to 8 cm. wide in shade leaves, or much smaller in sun leaves. Alchornea grows throughout the year and leaf-fall is continuous. The following figures give the lengths of the laminas of five consecutive leaves on the same shoot.

Date.	A. Size.	Rate.	B. Size.	Rate.	C. Size.	Rate.	D. Size.	Rate.	E. Size.	Rate.
Mar 20 ...	48	—	26	—	17	—	11	—	7	—
Apr. 2 ...	80	2·46	49	1·77	32	1·15	20	·69	11	·30
Apr. 18 ...	116	2·26	89	2·50	61	1·81	47	1·69	27	1·00
May 11 ...	119	—	111	·95	86	1·09	114	2·91	79	2·26

* For the literature of this subject the reader is referred to Schimper, Plant Geography, Oxford Ed. pp. 218 ff., and to a more recent paper of Lock, R.H., on the Growth of Giant Bamboos. Ann. Royal Bot. Gard. Peradeniya, Vol. II. Pt. 2, Aug. 1904.

The rate of growth of each leaf increases from the beginning until it is about half the mature size and then falls. The highest daily rates observed in Boehmeria and Alchornea, 4·4 mm. and 2·9 mm. respectively, are the most rapid found in any of the 14 forms that I measured, excepting in the tree-ferns. These figures contrast markedly with the rates of 107 mm. per day for the banana and 41 mm. for Amherstia. From eye observations of growth in a number of other species I should say that the above rates are but slightly if at all exceeded in any of the forms not measured, with the possible exception of *Brunellia comocladifolia*, Humb. & Bonpl.

Clethra tinifolia, Sw. is a characteristic forest tree with leaves 10 to 15 cm. long by 4 to 7 cm. wide. It is almost completely deciduous and remains for about six weeks in this condition, new leaves beginning to appear about the middle of March. The following measurements were made on newly unfolding leaves on a tree which was almost bare of old foliage.

Date.	A. Size.	Rate.	B. Size.	Rate.	C. Size.	Rate.	E. Size.	Rate.
Mar. 20 ...	31	—	26	—	31	—	23	—
Apr. 2 ...	55	1·84	47	1·61	54	1·74	41	1·38
Apr. 18 ...	88	2·06	80	2·06	81	1·69	66	1·56
May 11 ...	94	·26	91	·47	87	·26	90	1·04

Other trees in the Cinchona region which shed their foliage completely in the late winter and renew it during March and April are *Viburnum glabratum*, H. B. K., *V. villosum*, Sw. and *Rhamnus sphaerosperma*, Sw. Although I have made no exact measurements on these forms yet almost daily observation of certain trees during the time of leaf-growth makes certain that their rate is not at all more rapid than that of Clethra.

Tovomita havetioides, Griseb. is a small tree with leaves 8 to 11 cm. long by 4 to 6 cm. wide. The twigs are stout and the leaves leathery, about 3 mm. thick and possessing a latex, features which give the tree an aspect of being slow in growth. The measurements include the short petiole.

Date.	A. Size.	Rate.	B. Size.	Rate.
Mar. 20	44	—	41	—
Apr. 2	60	1·23	52	·84
Apr. 18	80	1·25	66	·87
May 11	109	1·26	88	·95

Elongation here proceeds with a greater uniformity during the development of the leaf than is the case in any thin leaved forms measured, but the rate is not strikingly slower than in Clethra.

The slowest rates of growth observed were for the leaves of *Pilea nigrescens*, Urb., one of the commonest terrestrial herbaceous plants of the forest. The mature leaves of this plant are extremely variable in size, as for example 89 by 41 mm., 78 by 36, 52 by 34, 41 by 28. The appearance of inflorescences between March 20 and April 2 in the axils of leaves below those being measured invalidate to some extent the measurements after the latter date.

Date.	A. Size.	Rate.	B. Size.	Rate.	C. Size.	Rate.
Feb. 20 ...	12	—	28	—	15	—
Mar. 5 ...	14	·15	31	·23	20	·38
Mar. 20 ...	19	·33	36	·33	24	·26
Apr. 2 ...	22	·23	42	·46	27	·23
Apr. 18 ...	25	·19	46	·25	30	·19
May 11 ...	28	·13	55	·38	34	·17

The most rapid growth observable in the rain forest is the unfolding of the fronds of certain species of tree-ferns. The presence of food reserves in the trunk places this phenomenon in a different class from leaf elongation in the spermaphytic trees. The following measurements on *Cyathea pubescens*, Mett. are for consecutive fronds of the same individual.

Date.	A. length.	Rate.	B. length.	Rate.	C. length.	Rate.	D. length.	Rate.
Dec. 4 ...	—	—	356	—	710	—	1,410	—
Dec. 9 ...	122	—	350	38·8	915	41·0	1,588	35·6
Dec. 18 ...	222	11·1	990	48·9	1,360	49·4	1,923	37·2
Feb. 1 ...	1,696	32·7	—	—	2,364	22·3	—	—

As noted above, all months of the year are favourable for activity in the domains of growth and reproduction so far as respects temperature and rainfall. To this fact is to be attributed the general correspondence of the periodic phenomena with those of tropical lowlands. The climate exhibits, however, on closer examination several features which are inhibitory to photosynthesis,—notably the high percentage of cloudiness and the prevalence of fog, which cut down the light intensity,—as well as features which are inhibitory to transpiration, chiefly the high humidity and the relative infrequency of direct insolation. I take it that the slow rates of leaf growth observed are a cumulative result in the activities of the plant of the combined conditions unfavourable to photosynthesis and transpiration.

In the grounds of Cinchona have been planted *Liriodendron* *tulipifera* and *Liquidambar styraciflua*. The rate of leaf growth in these trees seemed to me to be much lower than it is in their native range, although I have not yet exact comparative measurements to prove this.

What the rates of leaf growth at Cinchona may be in the drier brighter months of summer I am unable to say. How the rates here shown may compare with those in lowland trees which are not conspicuously rapid in growth I am also unable to say.

The facts present indicate: (a) that the rate of leaf growth in the trees of the Jamaican montane rain-forest is very slow as compared with that in tropical trees in which it has already been measured; (b) the renewing foliage of deciduous trees does not grow more rapidly than that of evergreen broad-leaf trees; (c) the prevalence of conditions unfavourable to both photosynthesis and transpiration would seem to offer at least a partial explanation of the slow rates of growth.

REFORM IN RURAL EDUCATION.

The Gloucester conference on rural education in 1904 directed public attention to the need for adapting rural education to rural requirements. Several country education authorities have since instituted inquiries into the subject, chambers of agriculture have passed resolutions, and now the County Councils Association, through its Rural Education Sub-Committee, has published a "Memorandum as to certain subjects suitable for the upper standards of elementary schools, and for evening schools in rural districts." This memorandum is worthy of careful examination. The case for reform may first be briefly stated.

It is a disturbing thought that during the past half-century scientific method has largely disappeared from rural elementary education. The child whose education chiefly consisted in learning from what he saw and did in the field, sheepfold and farmstead, grew into a man who, though his range of view was limited, possessed a remarkable store of accurate first-hand knowledge upon those things which concerned his work in life. With the introduction of a system of compulsory schooling, in which knowledge was principally gained from the lips of the teacher, the scientific method of basing knowledge on individual experience largely disappeared. Now faculties, while easily developed in children, as easily become atrophied through disuse, and under the present system, it is too often the case that lads as they leave school have neither the power of intelligent observation which is essential to success in rural industry, nor have they acquired an interest in country things. In the absence of such interests, the amusements of a town prove an irresistible attraction, and this, it is believed, has been one of the factors in bringing about rural depopulation and the scarcity of skilled men on the farms, while at the same time we meet in every London street with able-bodied out-of-works.

In the memorandum of the County Councils Association, nothing is said about less schooling, but the guiding principle in all the subjects of the curriculum is to be to *let surroundings teach*, and thus to put back scientific method into rural education. Geography and history are to be based on the physical features of, or the events associated with, the neighbourhood. In arithmetic, out-of-door measurement of land, crops, stacks, and cisterns is to be introduced. School-gardening is to be regarded not merely as instruction in the operations of gardening, but as a study of the growth of crops in relation to the soil. Thus although no teaching of agriculture is to be introduced, partly perhaps because the teachers are not qualified to teach it, partly because it would be waste of time to those boys who do not afterwards follow agricultural pursuits, still knowledge of surroundings is being acquired, habits of intelligent observation are being cultivated, and every subject of the school curriculum is acquiring a reality which no oral teaching could ever give it, and which must render the education a better training for life, whatever the after careers of the lads may be.

But while agriculture is not taught, it is noticeable that in the study of surroundings such subjects are suggested as will yield knowledge that is useful to the farmer or farmhand. For example, the boys are to collect the farm and garden weeds, and study their root systems and time of seeding with the view of learning the reasons for their abundance and the best means of dealing with them. From the point of view of cultivating intelligent observation, such an exercise is as good as one that has no utilitarian bearing, and it has this additional value, that the boys learn to apply their knowledge to the practical purposes of rural life.

This idea of *purpose* is kept prominently in view in all the subjects named in the memorandum. Manual work naturally takes an important place, for it is as necessary to cultivate the habit of manual work in childhood as it is the habit of intelligent observation, and its neglect has been another factor in the preference shown by lads after leaving school for non-rural employment, and therefore in rural depopulation. But again, the manual work is to have purpose. The woodwork is to be directed to making useful things, the gardening to growing useful vegetables, and thus, the boys' hearts, as well as their heads and hands, become impressed into their education.

One omission is noticeable—that the teaching of science finds no place in the suggestions. But to acquire a scientific habit of mind, the study of a science is certainly not necessary, nor even perhaps desirable, for children of twelve and thirteen. It is nature-study rather than the study of a natural science that is advocated, for while the correlation of a number of facts or phenomena of the same kind is likely to weary children, the co-ordination of one fact or phenomenon with others of a different order stimulates their interest and widens their outlook, and permits more readily of application to the purposes of daily life.

The memorandum is followed by a series of "suggestions for the encouragement of rural education." These include the establishment of junior naturalist societies and boys' agricultural clubs, nature-study exhibitions, and school museums of local natural history, together with a suggestion that facilities should be provided for the training of teachers in rural subjects.—(Nature, June 6, 1907.)

BOARD OF AGRICULTURE.

Extracts from Proceedings.

The usual monthly meeting of the Board of Agriculture was held on 20th November; present—Hon. H. Clarence Bourne, Colonial Secretary, in the Chair, Director of Public Gardens, Island Chemist, His Grace the Archbishop, Superintending Inspector of Schools, Messrs D. Campbell, G. D. Murray, Conrad Watson and the Secretary, Mr. John Barclay.

Cotton—His Grace the Archbishop said he had to leave the meeting early and he asked permission to speak on the subject of cotton to which he had referred at the previous meeting. He said he felt deeply that something ought to be done at the present time in order to get the cotton industry started amongst the small cultivators among whom their chief duty largely lay. They first ought to issue an authoritative statement as to the most suitable land, proper seed to use, and suitable times to plant, all brought up to date with the knowledge they had now available. A great deal had occurred to discourage them but there had been also some encouragement. He had written Mr. Sharp on the subject in order to avail himself of his experience and he asked that Mr. Sharp's reply be circulated amongst the members.

Mr. Fawcett mentioned that the A.B.C. of Cotton Culture issued by the Imperial Department of Agriculture covered all the ground mentioned by the Archbishop and was most complete in every detail.

His Grace said let them draw from it all the knowledge they could but their statement or pamphlet must be local, to deal with suitable localities for cotton and suitable times to plant which the A.B.C. could not cover.

Mr. Watson said he was sorry he could not agree with His Grace. In the other West Indian islands settlers had failed at first in the cultivation of Sea Island Cotton: it was the most difficult crop to grow he knew of and required special attention, care, knowledge and promptitude such as settlers would not be likely to give, and if large proprietors could not succeed, small settlers could not. He thought it would be better to delay inducing small settlers to plant until large fields had been grown, when, if there was anything in it, there would be plenty of buyers and small settlers would soon grow the cotton.

His Grace said he could not adopt Mr. Watson's conclusions as regards small settlers in Jamaica. They had had a good deal of agricultural instruction among them which had been responded to, to a considerable extent, and he thought indeed that no time should be lost in getting those in suitable districts accustomed to growing cotton on a small scale.

The matter was left for further discussion.

Teachers' Course.—The Secretary read letter from Mr. A. B. McFarlane intimating that as the accommodation at the Mico Training College was very limited this year owing to the damage done by the earthquake, he would suggest that the Course be postponed, but if it was considered advisable to hold it with reduced numbers —say 40—he would be willing to superintend as before.

After discussion, the Board were of opinion that it was desirable to hold the Teachers' Course as usual in January, even if a reduction in numbers was necessary through want of accommodation.

Agricultural Course.—Letter was submitted from the Colonial Secretary's Office re Agricultural Course at the Laboratory which had been suspended since the beginning of the year. The Chairman stated that it had been arranged that the examination be held in December, and the Course commencing in January would therefore be attended by the three scholars for 1907, and three scholars for 1908.

It was intimated that the Apprentices' Quarters at Hope would be complete before December.

Rat Virus—The Secretary read letter from the Colonial Secretary's Office, enclosing copy of letter written to His Britannic Majesty's Envoy Extraordinary in the city of Mexico asking him if he would be good enough to approach the Mexican Government to send on another sample of Rat Virus here, taking all precautions to obviate its being subjected to undue heat.

The Chemist was asked how he was progressing with the local virus. The Chemist explained that to test the various kinds of rat virus on the market thoroughly and then test the cultures they produced for the destruction of rats on a field scale would take nearly a year. They found it comparatively easy to grow the culture in the Laboratory and he would soon be in a position to ask some of those who were most interested to make tests.

Vanilla—The Secretary submitted extracts from a report by Mr. Palache of his visit with the Rev. John Maxwell to the Vanilla-producing districts. This was directed to be circulated.

Letter from Mr. Briscoe re St. Thomas-in-the-East—The Secretary submitted a letter from Mr. Briscoe to the Director of Public Gardens stating that he had arranged to spend a special fortnight in the Bath district in cocoa interests, and that he had just been nearly a week in Trinity Ville district with Mr. Barclay but that if he had to spend any further prolonged period in St. Thomas-in-the-East, his travelling allowance would not carry him through. He was directed to do the best he could till the end of the financial year and arrange to pay a visit to St. Thomas for as long a period as possible at the beginning of the next financial year.

School Gardens—The Secretary submitted a letter from the Colonial Secretary's Office re School Gardens enclosing an appreciation from the Rev. A. Swift, Priestman's River, on Mr. Murray's visit to the district in connection with School Gardens.

The Superintending Inspector of Schools submitted a report by Mr. Murray on his visit to School Gardens in Clarendon and Manchester. This was also directed to be circulated.

Laboratory—A report from the Island Chemist was submitted intimating that owing to the resignation of Messrs. Thompson and Richards who had received promotion in other Departments, he proposed to make good the loss by starting to train some more beginners and that he had advertised for four apprentices to be paid out of the lapsed pay of the two officers that had left.

This was agreed to.

The following reports from the Director of Public Gardens were submitted :—

1. Report Experiment Station.
2. Instructors Reports and Itineraries.
3. Letter from Mr. Cradwick.

With reference to cocoa trees suddenly dying out, and submitting specimen of the roots which showed that the trunk had been buried fully six inches below the surface of the soil, Mr. Cradwick reported that through this and lack of drainage the tree had died, though there were also evidences of a fungoid growth on the bark. There was no sign of "Fiddler Bugs" having touched this tree at all in spite of its sickness.

This letter was directed to be circulated for remarks.

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OF THE

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EDITED BY

WILLIAM FAWCETT, B.Sc., F.L.S.,

Director of Public Gardens and Plantations.

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KINGSTON, JAMAICA:
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1907.

JAMAICA.

BULLETIN

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THE SEDGES OF JAMAICA.

By N. L. Britton.

The list of species of Cyperaceae published herewith is based primarily on collections in the herbarium of the New York Botanical Garden, supplemented by those in the herbarium of the Department of Public Gardens and Plantations, and by notes taken at the herbaria of the Royal Gardens at Kew and at the British Museum of Natural History. The principal literature consulted has been the Monograph of the West Indian Cyperaceae by the late Mr. C. B. Clarke, published by Professor Urban in the second volume of his Symbolae Antillanae, Grisebach's Flora of the British West Indies, and the several papers of O. Boeckeler.

Most of the species may be regarded as satisfactorily known, and their general distribution ascertained, but a considerable number are, as will be seen in the enumeration, known only from single specimens secured by the older collectors, so that very much remains to be done in order to ascertain their relative abundance or rarity, their habitats and distribution; in some cases the only record that we have is that the specimen was collected somewhere on the island, and in a few instances it is suspected that errors have been made in the origin of the plant cited, through a mixture of labels in the older herbaria, or in some other way.

I have accepted the generic limits outlined by Mr. Clarke in the paper above cited with the exception of his treatment of *Cyperus* and its segregates, where I have accepted the view of previous authors in taking Cyperus in its broad sense rather than recognizing the genera *Pycraens, Mariscus,* and *Torulinium,* as I believe the characters depended on by Mr. Clarke for the maintenance of these genera are too vague for satisfactory use. It is my opinion that either this course must be taken, or that *Eleocharis, Scirpus* and *Rynchospora* must also be split up in order to be consistent. On the other hand, I accept the genus *Abildgaardia* as distinct from *Fimbristylis,* though I am not altogether clear that this position is readily defensible. I have also diverged from Mr. Clarke's treatment in accepting the generic name *Stenophyllus,* for the plants he includes under *Bulbostylis,* the former name having evident priority and being based on a well-known type.

The paper is submitted as a contribution to knowledge of the Jamaica flora from the Tropical Laboratory of the New York Botanical Garden at Cinchona, which is held as a research station through the cordial co-operation of the Colonial Government. One of the great needs of this research station is a more accurate knowledge of the flora of the island for the use of students either in residence there or at other institutions, and it is hoped that such a descriptive flora may be prepared in co-operation with the botanists of the Government at no distant date. In order to accomplish this, however, a very large amount of additional exploration must be done; the co-operative arrangement now in progress is rapidly supplying much needed material through the collecting trips of Mr. William Harris, Superintendent of Hope Gardens, but his valuable time for this purpose is naturally limited and should be supplemented by the work of other collectors in order that the information necessary may be more rapidly obtained.

References to specimens and their collectors have been restricted for the most part to work of the last few years, the older specimens being comprehensively cited by Mr. C. B. Clarke in his monograph.

KEY TO THE GENERA OF JAMAICAN CYPERACEAE.

A. Fertile flowers perfect
- 1. Basal empty scales of the spikelets none, or not more than two
  - Scales of the spikelets distichous
    - Spikelets with only one perfect flower — 1. *Kyllinga*
    - Spikelets with 2 to many perfect flowers — 2. *Cyperus*
  - Scales spirally imbricated (apparently distichous in *Abildgaardia*)
    - Base of the style persistent as a tubercle on the achene
      - Spikelet 1: bristles of the perianth usually present; culms leafless — 3. *Eleocharis*
      - Spikelets several or numerous; bristles none; culms leaf-bearing — 4. *Stenophyllus*
    - Base of the style not persistent as a tubercle
      - Flowers with no broad sepals nor perianth-scales
        - Base of the style swollen; perianth-bristles none
          - Scales of the nearly terete spikelets spirally imbricated — 5. *Fimbristylis*
          - Scales of the distinctly flattened spikelet subdistichous — 6. *Abildgaardia*
        - Base of the style not swollen; bristles usually present
          - Bristles 8 or fewer, short, rarely none — 7. *Scirpus*
          - Bristles numerous, long-exserted — 8. *Eriophorum*
      - Flowers with a perianth of 3 broad sepals — 9. *Fuirena*

2. Basal empty scales of the spikelets 3 or more
   Style 2-cleft, its base persistent as a tubercle on the achene
      Bristles none; culm monocephalous — 10. *Dichromena*
      Bristles usually present; culm usually polycephalous — 11. *Rynchospora*
   Style 3-cleft, its base fused with the top of the achene — 12. *Cladium*

B. Flowers all imperfect; monoecious or dioecious sedges.
   Pistillate flowers subtended by a scale; achene bony — 13. *Scleria*
   Pistillate flowers enclosed by a perigynium (utricle)
      A long hooked bristle protruding from the perigynium — 14. *Uncinia*
      No hooked bristle — 15. *Carex*

1. KYLLINGA, Rottb. Descr. et Ic. 2. *1773*.

Rootstock short or none; culms tufted
   Fertile scale of the spikelet setulose on the keel — 1. *K. pumila*
   Fertile scale of the spikelet smooth on the keel — 2. *K. odorata*
Rootstock elongated; culms not tufted
   Leaf-blades short or elongated
      Leaf-blades short, acute — 3. *K. pungens*
      Leaf-blades long, attenuate — 4. *K. brevifolia*
   Leaves reduced to sheaths — 5. *K. peruviana*

Type species, *Kyllinga monocephala*, Rottb.

1. KYLLINGA PUMILA, Michx. Fl. Bor. Amer. I: 28. 1803.

Roadside ditch, Stony Hill (Britton 832). Widely distributed in temperate and tropical America.

2. KYLLINGA ODORATA, Vahl, Enum. II: 382. 1806.
Kyllinga triceps, Griseb. Fl. Br. W. I. 568. 1866. Not Rottb. 1773.

In the lawns at Castleton Gardens (Britton 834); Temple Hall (Harris 9390). Previously collected in Jamaica by W. Wright. Widely distributed in warm and tropical America.

3. KYLLINGA PUNGENS, Link, Hort. Berol. I: 326. 1827.

Banks and along roads at higher elevations. Near Silver Hill Gap (Maxon 1124); Cinchona (Shreve; Harris 9501); Morce's Gap (Britton 217); Hardware Gap (Nichols 104). Not hitherto recorded from Jamaica.

4. KYLLINGA BREVIFOLIA, Rottb. Descr. et Ic. 13. 1773.
Kyllinga monocephala, Thunb. Fl. Jap. 35. 1784. Not Rottb. 1773.

In moist ground, common. Cinchona (Harris 9496, 9498). Marsh near Balaclava (Marble 704). Grisebach in Flora British West Indies attributes both *K. brevifolia*, Rottb. and *K. monocephala*. Rottb. to Jamaica but the latter is purely an Old World species,

5. KYLLINGA PERUVIANA, Lam. Encyc. III: 366. 1789.

Mariscus aphyllus, Vahl, Enum. II: 373. 1806.
Kyllinga aphylla, Kunth, Enum. II: 127. 1837.

Obtained in Jamaica by several collectors; not observed by us (J.P. 843).

2. CYPERUS L. Sp. Pl. 44. 1753.

Style-branches 2: achene lenticular
Achene dorsally flattened — 1. *C. laevigatus*
Achene laterally flattened
Scales of the spikelets blunt, straw-colour — 2. *C. densus*
Scales of the spikelets acute
Scales 1.5 mm. long, dull; inflorescence compact — 3. *C. odoratus*
Scales 2-2.5 mm. long, shining: inflorescence loose — 4. *C. paniculatus*

Style-branches 3; achene turgid or trigonous
A. Spikelets more or less flattened, not breaking up at the nodes
1. Rachis of the spikelet persistent, the scales falling away from it
a. Rachis-wings none, or very narrow
Plants annual
Scales sharply acuminate — 5. *C. compressus*
Scales obtusish, often with purplish margins — 6. *C. sphacelatus*
Plants perennial
Spikelets only 1 or 2; culm and leaves filiform — 7. *C. trichodes*
Spikelets several or numerous
Spikelets spicate, about 1 mm. wide — 8. *C. distans*
Spikelets digitate
Stamens 3 or 2
Scales acute or acuminate; basal leaves reduced to sheaths — 9. *C. Haspan*
Scales mucronate or short-awned; basal leaves normal
Leaves convolute, at least in drying
Achene narrowly linear-oblong — 10. *C. oxylepis*
Achene obovoid; culm viscid — 11. *C. elegans*
Leaves flat, grass-like — 12. *C. diffusus*
Stamen only 1.
Spikelets lanceolate to oblong-lanceolate — 13. *C. ochraceus*
Spikelets ovate, elongating in age.

Leaves 5-6 mm. wide, transversely nerved between the veins — 14. *C. vegetus*
Leaves 2-3 mm. wide, not transversely nerved between the veins — 15. *C. surinamensis*

b. Rachis distinctly winged.
Plants perennial by root-stocks
Basal leaves grass-like; weed of waste and cultivated ground — 16. *C. rotundus*
Basal leaves reduced to sheaths; tall marsh sedges with pseudo-septate culms
Culm terete — 17. *C. articulatus*
Culm trigonous at the apex — 18. *C. nodosus*
Annuals, flowering the first season
Basal leaves reduced to sheaths; involucral leaves very numerous, longer than the umbels — 19. *C. giganteus*
Basal leaves normal, half as long as the culm or longer — 20. *C. radiatus*

2. Rachis of the spikelet falling away above the two lower empty scales
Achene narrowly linear-oblong, 2.5 to 4 times as long as thick
Spikelets spicate, several-flowered — 21. *C. platystachys*
Spikelets capitate or capitate-spicate, only 1-4—flowered.
Heads globose — 22. *C. globulosus*
Heads cylindric — 23. *C. cyperoides*
Achene obovoid or oblong, not more than twice as long as thick
Spikelets 1-5—flowered
Umbel simple, or culm monocephalous
Scales of the spikelets imbricated
Spikelets loosely spicate, tetragonous — 24. *C. tetragonus*
Spikelets densely spicate or capitate
Spikelets 2-5 mm. long — 25. *C. cayennensis*
Spikelets 1.5 mm. long or less
Spikes several, rarely solitary; leaves 2-3 mm. wide — 26. *C. Swartzii*
Spike solitary, rarely 2; culms and leaves almost filiform — 27. *C. granularis*

Scales of the spikelets distant; leaves 2 mm. wide or less; slender sedges	
Spikelets 4-5 mm. long	28. *C. tenuis*
Spikelets 2 mm. long or less	29. *C. nanus*
Umbel compound	
Spikes ovoid, 8-12 mm. thick	30. *C. Mutisii*
Spikes long-cylindric, 5-7 mm. thick	31. *C. ligularis*
Spikelets 15-25—flowered	
Scales acute or mucronulate. awnless	32. *C. brunneus*
Scales awned, appressed	33. *C. confertus*
B. Spikelets nearly or quite terete, breaking up at the nodes into 1-fruited joints	
Spikes solitary or 2; culm filiform; perennial by rootstocks	34. *C. filiformis*
Spikes umbellate; culms stout to slender; annuals, or at least without rootstocks.	
Scales distant, not overlapping	
Spikes loose; spikelets yellowish-brown	35. *C. ferax*
Spikes dense; spikelets red brown	36. *C. Vahlii*
Scales overlapping	37. *C. speciosus*

Type species, *Cyperus esculentus*, L.

1. CYPERUS LAEVIGATUS, L. Mant. 179. 1771.
Juncellus laevigatus, Clarke in Hook. f. Fl. Brit. Ind. VI: 596. 1893.
In marshes along the coast. Between Kingston and Spanish Town (Fawcett 8142); Rockfort (Britton 787; Harris 9564.) Widely distributed in warm and tropical regions both of the old world and the new.

2. CYPERUS DENSUS, Link, Jahrb. III: 83. 1820
Cyperus helvus, Liebm. Mex. Halvgr. 9. 1850.
Cyperus variegatus, Griseb. Fl. Br. W. I. 562. 1864. Not H. B. K.
Pycreus helvus, Clarke in Urban, Symb. Ant. II: 19. 1900.
Frequent in marshes and ditches. Temple Hall (Harris 9392); Port Antonio (Britton 872); Stony Hill (Britton 833). Tropical America.

3. CYPERUS ODORATUS, L. Sp. Pl. 46. 1753.
Cyperus polystachyus, R. Br. Prodr. 214. 1810.
Pycreus polystachyus, Beauv. Fl. d'Owar. II: 48. 1807.
Pycreus odoratus, Urban, Symb. Ant. II: 164. 1900.
In marshes near the coast, in the vicinity of Port Antonio (Marble 847; Britton 901). Not hitherto reported from Jamaica. Widely distributed in tropical regions.

4. CYPERUS PANICULATUS, Rottb. Descr. et Ic. 40. 1773.
Pycreus paniculatus, Nees, Linnaea, IX: 283. 1834.
Reported from Jamaica by Clarke, as collected by Purdie, under

the name *Pycreus polystachyus*, var. *laxiflora*, Ridley; moist ground, Troy (Britton 663). Warm and tropical America.

5. CYPERUS COMPRESSUS, L. Sp. Pl. 46. 1753.
Jamaica (Sloane, pl. 76 f. 1, cited by Linnaeus; Purdie). This common weed of nearly all warm and tropical countries does not appear to be abundant in Jamaica, as it is not represented in the herbarium of the Department of Public Gardens and Plantations.

6. CYPERUS SPHACELATUS, Rottb. Descr. et Ic. 26. 1773.
Jamaica, collected by several botanists as recorded by Grisebach and by Clarke (J. P. 853). Common in most parts of Tropical America.

7. CYPERUS TRICHODES, Griseb. Fl. Br. W.I. 564. 1864.
Marshes at lower elevations; apparently local. Near Balaclava (Marble 706.) Endemic.

8. CYPERUS DISTANS, L. f. Suppl. 103. 1781.
Frequent in wet or moist soil at middle elevations. Banks, Content Gap (Britton 39). Previously accredited to Jamaica by Swartz. Widely distributed in warm and tropical regions.

9. CYPERUS HASPAN, L. Sp. Pl. 45. 1753.
Marshes and wet meadows, collected by Alexander and by Wullschlaegel. Widely distributed in warm and tropical regions.

10. CYPERUS OXYLEPIS, Nees; Steud. Syn. Pl. Cyp. 25. 1855.
Collected in Jamaica by Alexander as recorded by Clarke. Northern South America.

11. CYPERUS ELEGANS, L. Sp. Pl. 45. 1753.
Cyperus viscosus, Sw. Prodr. 20. 1788.
Occasional in marshes at low elevations. Also on Cayman Brac (Millspaugh 1171). Common throughout the West Indies; Central America to Argentina.

12. CYPERUS DIFFUSUS, Vahl, Enum. II: 321. 1806.
Cyperus laxus, Griseb. Fl. Br. W. I. 563. 1864. Not Lam.
Frequent on moist banks and hillsides up to 500 m. Near Gordon Town (Britton 3); near Castleton (Underwood 113). Widely distributed in tropical regions, but not known from the northern West Indies.

13. CYPERUS OCHRACEUS, Vahl, Enum. II: 325. 1806.
Frequent in marshes and ditches at elevations up to 500 m. Port Antonio (Britton 858); near St. Paul, Cockpit Country (Marble 700): Mona Estate near Hope (Harris 8846; 8942). Widely distributed in Tropical America.

14. CYPERUS VEGETUS, Willd. Sp. Pl. I: 283. 1797.
Along a brook, Troy (Britton 460). Not otherwise known from the West Indies. Distribution: California to Chili.

15. CYPERUS SURINAMENSIS, Rottb. Descr. et Ic. 35. 1773.
This widely distributed Tropical American sedge is known to me from Jamaica only by a specimen collected by Hart, mixed with *C. ochraceus*, as recorded by Clarke.

16. CYPERUS ROTUNDUS, L. Sp. Pl. 45. 1753.
A weed in waste places and cultivated soil. Widely distributed in warm and tropical regions.

17. CYPERUS ARTICULATUS, L. Sp. Pl. 44. 1753.
Common in marshes at lower altitudes. Near Ferry River (Britton 392); Resource (Harris 6917). Widely distributed in tropical regions.

18. CYPERUS NODOSUS, Willd. Enum. Hort. Berol. 72. 1809. Recorded from Jamaica by Clarke, as collected by March. Distribution: Central America, Northern South America; Martinique.

19. CYPERUS GIGANTEUS, Vahl, Enum. II: 364. 1806.

Cyperus elatus, Griseb. Fl. Br. W. I. 566, in part. 1866.

Coastal marshes and along lagoons. Ferry River (Fawcett & Harris; Britton 396). West Indies and Central America to Uruguay.

20. CYPERUS RADIATUS, Vahl, Enum. II: 369. 1806.

Shown in the Kew Herbarium by a specimen from Jamaica, according to Clarke, the collector not cited. Distribution: tropical regions of the Old World and the New.

21. CYPERUS PLATYSTACHYUS, Griseb. Fl. Br. W. I. 567. 1864.

Mariscus flabelliformis, H. B. K. Nov. Gen. & Sp. I: 215. 1815. Not *Cyperus flabelliformis*, Rottb.

Frequent on banks and along streams at low and middle elevations. Near Gordon Town (Britton 5); Troy (Britton 613): near Port Antonio (Earle 625). Central America and northern South America: Martinique.

22. CYPERUS GLOBULOSUS, Aubl. Pl. Guiana, I: 47. 1775.

Mariscus echinatus, Ell. Bot. S. C. & Ga. I: 75. 1816.

Cyperus cyclostachyus, Griseb. Fl. Br. W. I. 567. 1864.

Mariscus globulosus, Urban, Symb. Ant. II: 165. 1900.

Jamaica, collected by March and by Hart. Distribution: Southeastern United States; Bermuda; Porto Rico (according to Clarke); Guiana.

23. CYPERUS CYPEROIDES (L.) Britton

Scirpus cyperoides, L. Mant. II: 181. 1771.

Mariscus Sieberianus, Nees, Linnaea, 9': 286. 1834 (hyponym)

Mariscus cyperoides. Urban, Symb. Ant. II: 164. 1900.

Collected in Jamaica by Hart and by Wullschlaegel, as cited by Clarke. Introduced from Tropical Asia or Africa. Also in Trinidad.

24. CYPERUS TETRAGONUS, Ell. Bot. S. C. & Ga. I: 71. 1816.

Cyperus anceps, Liebm. Mex. Halvgr. 25. 1850.

Mariscus tetragonus, Clarke in Urban, Symb. Ant. I: 44. 1900.

Recorded by Clarke from Jamaica as collected by Wullschlaegel. Distribution: southeastern United States and Mexico.

25. CYPERUS CAYENNENSIS, (Lam.) Britton

Kyllinga cayennensis, Lam. Ill. I: 149. 1791.

Mariscus flavus, Vahl, Enum. II: 374. 1806.

Cyperus flavomariscus, Griseb. Fl. Br. W. I. 567. 1864.

Mariscus cayennensis, Urban, Symb. Ant. II: 165. 1900.

In fields and on banks, frequent. Vicinity of Constant Spring (Maxon 2155). Southeastern United States and Mexico to Patagonia.

26. CYPERUS SWARTZII (Dietr.) Boeckl.

Mariscus Swartzii, Dietr. Sp. Pl. II: 343. 1833.

Kyllinga filiformis, Sw. Prodr. 20. 1788. Not *Cyperus filiformis* Sw.

Cyperus caymanensis, Millsp. Field Col. Mus. Bot. II: 120. 1900.

Recorded by Grisebach and by Clarke. Jamaica Plants No. 1561, in herb. Public Gardens (Rev. Bassett Key). Grand Cayman (Millspaugh 1334). Distribution: Jamaica, Haiti, Cuba, Guadaloupe.

27. CYPERUS GRANULARIS (Desf.) Britton

Kyllinga granularis, Desf.; Boeckl. Linnaea, XXXV: 432. 1867-68

Cyperus nanus, Boeckl. in Engler's Bot. Jahrb. I: 363. 1881. Not Willd. 1797.

Mariscus gracilis, Vahl, Enum. II.: 273. 1806. Not *Cyperus gracilis* R. Br.

Kyllinga filiformis, var. a, Griseb. Fl. Br. W. I. 568. 1864.

Jamaica (March 13, according to Clarke). Distribution: Haiti, Porto Rico, St. Martin, St. Croix.

28. CYPERUS TENUIS, Sw. Prodr. 20. 1788.

Mariscus tenuis, Clarke in Urban, Symb. Ant. II: 48. 1900.

Jamaica, collected by March and by Purdie. Distribution: Haiti and St. Croix.

29. CYPERUS NANUS, Willd. Sp. Pl. I: 272. 1796.

Schoenus capillaris, Sw. Prodr. 20. 1788. Not *Cyperus capillaris*, Koen.

Mariscus capillaris, Vahl, Enum. II: 372. 1806.

Kyllinga capillaris, Griseb. Kar. 120. 1857.

Jamaica (March 13, according to Clarke). Mr. Clarke cites this same collection number of March under *Mariscus gracilis*.

30. CYPERUS MUTISII (H. B. K.) Griseb. Fl. Br. W. I. 567. 1864.

Mariscus Mutisii, H. B. K. Nov. Gen. & Sp. I: 216. pl. 66. 1815.

Hillsides and banks at middle and higher altitudes. Cinchona (Underwood 424; Harris 9500; Shreve); near Gordon Town (Britton 13). Distribution: Haiti: Porto Rico: Mexico to Bolivia.

31. CYPERUS LIGULARIS, L. Amoen. Acad. V: 391. 1859.

Mariscus rufus, H. B. K. Nov. Gen. & Sp. I: 216. pl. 67. 1815.

Mariscus ligularis, Urban, Symb. Ant. II: 165. 1900.

Common along brackish marshes. Navy Island (Fredholm 3322). Grand Cayman (Millspaugh 1301). Widely distributed in the warm and tropical parts of America.

32. CYPERUS BRUNNEUS, Sw. Fl. Ind. Occ. I: 116. 1797.

Mariscus bruneus, Clarke in Urban, Symb. Ant. II: 51. 1900.

On sandy sea-beaches; also on the Cayman Islands. Distribution: sea-beaches and sand-dunes from Bermuda and Florida to Barbados and Central America.

33. CYPERUS CONFERTUS, Sw. Prodr. 20. 1788.

Mariscus confertus, Clarke in Urban, Symb. Ant. II: 50. 1900.

Banks and hillsides in the drier parts of the island. Near Hope (Harris 6641). Haiti: Porto Rico to Martinique; northern South America.

34. CYPERUS FILIFORMIS, Sw. Prodr. 20. 1788.

Torulinium filiforme, Clarke in Urban, Symb. Ant. II: 57. 1900.

Edges of marshes. Observed by us only near Balaclava (Marble

707), but obtained by the earlier collectors. Grand Cayman (Millspaugh 1296). Common in the West Indies.

35. CYPERUS FERAX, Rich. Act. Soc. Hist. Nat. Paris' I: 106. 1792.
Cyperus flexuosus, Vahl, Enum. II: 359. 1806.
Torulinium confertum, Hamilt. Prodr. Fl. Ind. Occ. 15. 1826.
Torulinium ferax, Urban, Symb. Ant. II: 165. 1900.

Common in swamps and along streams at low and middle elevations. Hartford, near Priestman's River (Maxon 2531); near St. Paul (Marble 699); Troy (Maxon 2930; Britton 471); Mona (Harris 8939). Widely distributed in warm and tropical parts of America.

36. CYPERUS VAHLII, (Nees) Steud. Syn. Pl. Cyp. 48. 1855.
Diclidium Vahlii, Nees in Mart. Fl. Bras. II: 53. 1843.
Cyperus flexuosus, Griseb. Pl. Cub. 238. 1866. Not Vahl. 1806.

Collected in Jamaica by Wilson as cited by Clarke; Jamaica Plants No. 844. Cuba; Haiti; Windward Islands.

37. CYPERUS SPECIOSUS, Vahl, Enum. II: 364. 1806.
Cyperus Michauxianus, Schultes in R. & S. Syst. II: Mant. 123. 1824.
Torulinium Michauxianum, Clarke in Urban, Symb. Ant. II: 56. 1900.

This species of Eastern North America is cited by Clarke as collected in Jamaica by W. Wright.

CYPERUS ALTERTNIFOLIUS, L., a widely cultivated ornamental species, native of Tropical Africa, has escaped from Castleton Gardens and become established along the Wag Water River as observed by Mr. William Harris.

3. ELEOCHARIS, R. Br. Prodr. Fl. Nov. Holl. I: 224. 1810.

Spikelet cylindric, scarcely or not at all thicker than the culm; scales coriaceous, not keeled
- Culms terete, nodose — 1. *E. interstincta*
- Culms angled, continuous — 2. *E. mutata*

Spikelet ovoid or oblong, thicker than the culm; scales membranous, keeled.
- Style-branches 2; achene lenticular or biconvex
  - Upper sheath with a membranous hyaline limb; rootstock slender — 3. *E. flaccida*
  - Upper sheath 1-toothed; rootstock none — 4. *E. capitata*
- Style-branches 3; achene 3-angled
  - Culms continuous
    - Culms setaceous or filiform
      - Achene cancellate; spikelet 1-4—flowered — 5. *E. retroflexa*
      - Achene smooth; spikelet 8-10—flowered — 6. *E. microcarpa*
    - Culms slender — 7. *E. albida*
  - Culms stout, pseudo-septate, constricted under the spikelet — 8. *E. geniculata*

Type species *Scirpus palustris*, L.

1. ELEOCHARIS INTERSTINCTA (Vahl) R. & S. Syst. II: 148. 1817.

Scirpus plantagineus, Griseb. Kar. 122. 1857.
Scirpus interstinctus, Vahl, Enum. II: 251. 1806.

Frequent in coastal marshes. Folly Point (Fredholm 3146). Very widely distributed in marshes from Rhode Island to temperate South America

2. ELEOCHARIS MUTATA (L.) R. & S. Syst. II: 155. 1817.

Scirpus mutatus, L. Amoen. Acad. V: 391. 1760.

Frequent or occasional in marshes. Near Ewarton (Harris 8513; Underwood 1861). Widely distributed in tropical America.

3. ELEOCHARIS FLACCIDA (Spreng.) Urban, Symb. Ant. II: 165. 1900.

Scirpus flaccidus, Spreng. Tent. Suppl. 3. 1828.
Scirpus ochreatus, Griseb. Fl. Br. W. I. 570. 1864.
Eleocharis ochreata, Nees, Linnaea, IX: 294. 1834.

In a brook, Troy (Britton 458); near Troy (Harris 8553). Widely distributed in tropical and warm-temperate America.

4. ELEOCHARIS CAPITATA (L.) R. Br. Prodr. 225. 1810.

Scirpus capitatus, L. Sp. Pl. 48. 1753.

In wet places, common at lower elevations. Near Annatto Bay (Maxon 1966); Rockfort (Britton 788; Harris 9380, 9565); Temple Hall (Harris 9389). In all tropical and subtropical regions.

5. ELEOCHARIS RETROFLEXA (Poir.) Urban, Symb. Ant. II: 165. 1900.

Scirpus retroflexus, Poir. in Lam. Encycl. VI: 753. 1804.
Eleocharis Chaetaria, R. & S. Syst.. II: 154. 1817.

Near Ewarton, around edges of a pond (Harris 8512; Underwood 1862; in a brook, Troy (Britton 451). Nearly throughout the West Indies and tropical South and Central America.

6. ELEOCHARIS MICROCARPA, Torr. Ann. Lyc. N. Y. III: 312. 1836.

Eleocharis minima, Kunth, Enum. II: 139. 1837.

Reported from Jamaica by Clarke, as collected by Purdie. Distributed from the southern United States and Mexico and the West Indies to Brazil. Torrey's type specimens were from New Orleans; the plant of the Atlantic United States from New Jersey southward which has been referred to this species is *E. Torreyana*, Boeckl.

7. ELEOCHARIS ALBIDA, Torr. Ann. Lyc. N. Y. III: 304. 1836.

Jamaica (Mac Nab, according to Clarke). Reported from Bermuda; otherwise known only from the south-eastern United States and Mexico.

8. ELEOCHARIS GENICULATA (L.) R. & S. Syst. II: 150. 1817

Scirpus geniculatus, L. Sp. Pl. 48. 1753.
Scirpus constrictus, Griseb. Kar. 122. 1857.

Common in marshes and ditches up to 1300 m. altitude. Near Castleton (Underwood 131): River Head near Ewarton (Underwood 1867); Content Road to Cinchona (Underwood 159); near Balaclava (Marble 913); Hardware Gap (Nichols 97). Tropical America. Jamaica is the type locality of this species.

4. STENOPHYLLUS, Raf. Neog. 4. 1825.

[BULBOSTYLIS, Kunth, Enum. II: 205. 1837.]

Leaves narrowly linear, 1.5 cm. long, or reduced nearly to sheaths; achene narrowly obovoid — 1. *S. subaphyllus*

Leaves setaceous; achene broadly obovoid — 2. *S. capillaris*

Type species, *Scirpus stenophyllus*, Ell.

1. STENOPHYLLUS SUBAPHYLLUS (Clarke) Britton

Bulbostylis subaphylla, Clarke in Urban, Symb. Ant. II: 86. 1900.

Summit of Bull Head Mountain (Underwood 3364). Otherwise known only from Cuba (C. Wright 1533, in part).

2. STENOPHYLLUS CAPILLARIS (L.) Britton, Bull. Torr. Club. XXI: 30. 1894.

Scirpus capillaris, L. Sp. Pl. 49. 1753.

Bulbostylis capillaris, Clarke in Hook. f. Fl. Br. Ind. VI: 652.

Recorded from Jamaica by Clarke as collected by Wullschlaegel; otherwise not known from the island. Common in the Eastern United States.

5. FIMBRISTYLIS, Vahl, Enum. II: 285. 1806.

Style 2-cleft
- Achene longitudinally ribbed — 1. *F. diphylla*
- Achene reticulated
  - Leaves nearly or quite as long as the culm; scales of the spikelets chestnut-brown — 2. *F. spadicea*
  - Leaves much shorter than the culm; scales of the spikelets pale brown or greenish.
    - Leaves very short; spikelets about 1 cm. long — 3. *F. ferruginea*
    - Leaves half as long as the culm; spikelets 3-6 mm. long — 4. *F. glomerata*

Style 3-cleft — 5. *F. complanata*

Type species, *Fimbristylis acuminata*, Vahl.

1. FIMBRISTYLIS DIPHYLLA (Retz.) Vahl, Enum. II: 289. 1806.

Scirpus diphyllus, Retz. Obs. V: 15. 1789.

Fimbristylis laxa, Vahl, loc. cit. 292. 1806.

Fimbristylis brizoides, Nees, Linnaea, IX: 290. 1834.

In fields and on banks, frequent. Near Port Antonio (Earle 624;j Fredholm 3301; Britton 866); near Troy (Harris 8707; Maxon 2810); Temple Hall (Harris 9391); Cinchona (Harris 9495). Widely distributed in tropical regions.

2. FIMBRISTYLIS SPADICEA (L.) Vahl, Enum. II: 294. 1806.

Scirpus spadiceus, L. Sp. Pl. 51. 1753.

Common in coastal marshes. Port Antonio (Britton 860). Jamaica is the type locality for this species (Sloane, I: 118, *pl. 76, f. 2*). Distribution: West Indies.

3. FIMBRISTYLIS FERRUGINEA (L.) Vahl, Enum. II: 291. 1806.

Scirpus ferrugineus, L. Sp. Pl. 50. 1753.

Common in coastal marshes. Port Antonio (Britton 906). Jamaica is the type locality. Distribution: West Indies.

4. FIMBRISTYLIS GLOMERATA (Retz.) Urban, Symb. Ant. II: 166. 1900.

Scirpus glomeratus, Retz. Obs. 4. 11. 1786.

Fimbristylis spathacea, Roth, Nov. Sp. 24. 1821.

Marshes, Port Antonio (Britton 863); roadside ditch, Rockfort (Britton 784; Harris 9318) Not hitherto recorded from Jamaica.

5. FIMBRISTYLIS COMPLANATA (Retz.) Link, Hort. Berol. I: 292. 1827.

Scirpus complanatus, Retz. Obs. V: 14. 1789.

Scirpus amentaceus, Griseb. Kar. 123. 1857.

Coastal marshes between Annotta Bay and Buff Bay (Britton 845) Widely distributed in tropical regions.

6. ABILDGAARDIA, Vahl, Enum. II: 296. 1806.

Type species, *Cyperus monostachyus*, L.

ABILDGAARDIA MONOSTACHYA, (L.,) Vahl Enum. II: 296 1806.

Cyperus monostachyus, L. Mant. 180. 1771.

Fimbristylis monostachya, Hassk. Pl Jav. Rar. 61. 1848.

Frequent on dry banks and in fields. Near Port Antonio (Fredholm 3277); Troy (Britton 439); between Potsdam and Lover's Leap (Britton 1138). Widely distributed in tropical regions.

7. SCIRPUS, L. Sp. Pl. 47. 1753.

Culms tall, stout	
Spikelets umbelled; culms terete	1. *S. validus*
Spikelets capitate; culm trigonous	2. *S. Olneyi*
Culms filiform, low	3. *S. caespitosus*

Type species, *Scirpus lacustris*, L.

1. SCIRPUS VALIDUS, Vahl, Enum. II: 268. 1806.

Frequent in coastal marshes. Ferry River (Fawcett & Harris 8089; Britton 398). Common in warm and tropical America.

2. SCIRPUS OLNEYI, A. Gray, Boston Journ. Nat Hist. V: 238. 1845.

Recorded by Clarke as collected in Jamaica by Bromfield. Distribution: United States and West Indies.

3. SCIRPUS CAESPITOSUS, L. Sp. Pl. 48. 1753.

This species of high mountains of the north temperate zone, is recorded by Boeckeler in Linnaea, XXXVI: 488, as occurring in Jamaica, but this is almost certainly an error.

8. ERIOPHORUM, L. Sp. Pl. 52 1753.

Type species, *Eriophorum vaginatum*, L.

1. ERIOPHORUM POLYSTACHYUM, L. Sp. Pl. 52. 1753.

Eriophorum angustifolium, Roth, Neue Beitr. 94. 1802.

Jamaica (W. Wright, according to Clarke). Known otherwise only from cold temperate regions; the identity of the specimen cited is open to suspicion.

9. FUIRENA Rottb. Descr. et Ic. 70. 1773.

Heads of spikelets numerous in a long panicle; leaves 8-12 mm. wide	1. *F. umbellata*
Heads of spikelets only 1 to 5; leaves 4 mm. wide or less	2. *F. squarrosa*

Type species, *Fuirena umbellata*, Rottb.

1. FUIRENA UMBELLATA, Rottb. Descr. et Ic. 70. 1773. Frequent in coastal marshes. Near Cold Harbour, east of Port Antonio (Britton 900). Widely distributed in tropical regions.

2. FUIRENA SQUARROSA, Michx. Fl. Bor. Am. I: 37. 1803. Jamaica, according to Vahl, but not found on the island by recent collectors. The species is widely distributed in the eastern United States and is reported from Cuba.

10. DICHROMENA, Michx. Fl. Bor. Am. I: 37. 1803.

Bracts of the involucre ciliate at the base
  Spikelets capitate-spicate; bracts white toward the base — 1. *D. ciliata*
  Spikelets 1-5; bracts mostly green throughout — 2. *D. radicans*
Bracts of the involucre not ciliate — 3. *D. colorata*

Type species, *Dichromena leucocephala*, Michx.

1. DICHROMENA CILIATA, Vahl, Enum. II: 240. 1806.
Rhynchospora pura, Griseb. Fl. Br. W. I. 577. 1864.
Grassy banks and meadows; frequent at low and middle elevations. Brandon Hill (Thompson 8101); Mansfield, Bath (Nichols 192); near Port Antonio (Fredholm 3021), Troy (Britton 447). Widely distributed in Tropical America.

2. DICHROMENA RADICANS, Schl. & Cham. Linnaea, VI: 28. 1831.
Rhynchospora Persooniana, Griseb. Fl. Br. W. I. 377. 1864
Meadow, near Hollymount (Britton 769). Widely distributed in Tropical America.

3. DICHROMENA COLORATA (L.) A. S. Hitchc. Rep. Mo. Bot. Gard. IV: 141. 1893.
Schoenus coloratus, L. Sp. Pl. 43. 1753.
Rynchospora stellata, Griseb. Kar. 123. 1857.
Dichromena leucocephala, Michx. Fl. Bor. Am. I: 37. 1803.
Recorded from Jamaica by Grisebach and by Clarke and represented in the herbarium of the Public Gardens. Grand Cayman (Millspaugh 1375). Distribution: Southern United States, West Indies and Central America.

11. RYNCHOSPORA Vahl, Enum. II: 229. 1806.

Style long, its branches much shorter than the lower undivided part
  Spikelets densely capitate — 1. *R. cyperoides*
  Spikelets in panicled clusters, not densely capitate
    Tubercle nearly or quite twice as long as the achene — 2. *R. Eggersiana*
    Tubercle shorter than the achene, or but little longer.
      Bristles about as long as the achene or longer — 3. *R. corymbosa*
      Bristles obsolete or none
        Spikelets fascicled, leaves 1.5–3 mm. wide — 4. *R. elongata*
        Spikelets not fascicled, the clusters loose; leaves 4 mm. wide — 5. *R. polyphylla*

Style short, its branches about as long as the lower undivided part.
- Bristles none
  - Spikelets 1-2 mm. long — 6. *R. micrantha*
  - Spikelets 3-6 mm. long
    - Achene not 3-toothed — 7. *R. Berterii*
    - Achene 3-toothed at the summit — 8. *R. setacea*
- Bristles present, upwardly barbed
  - Achene smooth — 9. *R. fascicularis*
  - Achene cancellate — 10. *R. cephalotes*
  - Achene transversely wrinkled
    - Bristles shorter than the achene; spikelets filiform-peduncled — 11. *R. rariflora*
    - Bristles as long as the achene or longer; spikelets not filiform-peduncled
      - Achene not stipitate; spikelets about 3 mm. long — 12. *R. glauca*
      - Achene stipitate; spikelets 5-7 mm. long — 13. *R. jubata*

Type species, *Rynchospora aurea*, Vahl.

1. RYNCHOSPORA CYPEROIDES (Sw.) Mart. Denksch. Acad. Wiss. Muench. VI: 149. 1816-17.

Schoenus cyperoides, Sw. Prodr. 19. 1788.

Meadow between Oxford and Wallingford (Britton 692); Oxford (Harris 9441). Not recorded by Clarke from Jamaica, but duly recorded by Grisebach. Widely distributed in Tropical America.

2. RYNCHOSPORA EGGERSIANA, Boeckl. Cyp. Nov. II. 26. 1890.

Rynchospora florida, Griseb. Fl. Br. W. I. 575. 1864.
Rynchospora aristata, Clarke in Urban, Symb. Ant. II: 115, in part, 1900.

Common in mountain woods. St. Catherine's Peak (Eggers 3596, type; Blue Mountain Peak (Shreve); John Crow Peak (Britton 276); Morce's Gap (Nichols 42; Britton 917); Cinchona (Underwood 468; Shreve; Britton 63). Endemic. Differs from the Mexican and South American *R. aristata*, Boeck. by its shorter tubercle, longer bristles and more conspicuously cancellate achene.

3. RYNCHOSPORA CORYMBOSA (L.) Britton, Trans. N. Y. Acad. Sci. XI: 85. 1902.

Scirpus corymbosus, L. Sp. Pl. 76. 1753.
Rynchospora aurea, Vahl, Enum. II. 229. 1806.
Schoenus surinamensis, Rottb. Descr. et Ic. 68. 1773.
Rynchospora surinamensis, Nees, Linnaea, IX: 297. 1834.

Marshes, Port Antonio (Britton 859). Not otherwise known from Jamaica, except as cited by Grisebach, collected long ago by Swartz, and not referred to by Clarke.

4. RYNCHOSPORA ELONGATA, Boeckl. Cyp. Nov. I: 261. 1888.

On shaded banks and in bogs at higher elevations. New Haven Gap (Shreve); near Cinchona (Britton 132); Morce's Gap (Britton 914). John Crow Peak (Britton 196); Sir John Peak (Britton 279); slopes below Sir John Peak (Harris 9550). Distribution: Jamaica; Porto Rico; Guadaloupe.

5. RYNCHOSPORA POLYPHYLLA, Vahl, Enum. II. 230. 1806.
Schoenus polyphyllus Vahl, Eclog. Am. II: 5. 1798.
Banks, hillsides and moist woods, common at higher and middle elevations. Cuna Cuna Pass (Fredholm 3240); Cinchona (Shreve; Harris 9502); John Crow Peak (Nichols 44); Content Gap (Britton 33); near Moore Town (Marble 851); Bull Head Mountain (Underwood 3379); Troy (Maxon 2817). Southern West Indies; Central America to Venezuela.

6. RYNCHOSPORA MICRANTHA, Vahl, Enum. II: 231. 1806. Edge of a brook, Troy (Britton 457). Widely distributed in Tropical America, and occurs also in Tropical Africa.

7. RYNCHOSPORA BERTERII (Spreng.) Clarke, in Urban, Symb. Ant. II: 119. 1900.
Schoenus pusillus, Sw. Prodr. 20. 1788.
Hypolytrum Berterii, Spreng. Neue Entd. I: 241. 1820.
Rynchospora pusilla, Griseb. Kar. 123. 1857. Not Curtis.
On moist banks, shaded rocks and along brooks and ditches at low and middle elevations. Near Troy (Harris 8691, 9420); Tyre (Britton 911); Oxford (Britton 428); Port Antonio (Fredholm 3114) Distribution: West Indies south to Guadaloupe.

8. RYNCHOSPORA SETACEA (Berg.) Boeckl. Vidensk. Medd. Kjob. 1869-70: 159.
Schoenus setaceus, Berg. Act. Helv. VII: 130. 1772.
Rynchospora tenerrima, Spreng. Syst. Cur. Post. 26. 1827.
Rynchospora Spermodon, Griseb. Fl. Br. W. I. 576. 1864.
Borders of marshes. Port Antonio (Britton 877); Moore Town (Marble 849). West Indies and tropical South America.

9. RYNCHOSPORA FASCICULARIS (Michx.) Vahl, Enum. II: 234. 1806.
Schoenus fascicularis, Michx. Fl. Bor. Am. I: 37. 1803.
Summit of Bull Head Mountain (Underwood 3364b); previously collected in Jamaica by Purdie. Distribution; Southeastern United States, Cuba, Haiti, Porto Rico.

10. RYNCHOSPORA CEPHALOTES (L.) Vahl, Enum. II: 237. 1806.
Scirpus cephalotes, L. Sp. Pl. Ed. 2, 76, 1762.
Jamaica (Masson, according to Clarke). Tobago; Trinidad; Central and South America.

11. RYNCHOSPORA RARIFLORA, (Michx.) Ell. Bot. S. Car. & Ga. I: 58. 1816.
Schoenus rariflorus, Michx. Fl. Bor. Am. I: 35. 1803.
Bull Head, Clarendon (Hart). The only station known for this species south of the Isle of Pines. Southeastern United States and Cuba.

12. RYNCHOSPORA GLAUCA, Vahl, Enum. II. 233. 1806.
Rynchospora gracilis, R. & S. Syst. II: 85. 1817.
Summit of Bull Head Mountain (Underwood 3364a). Widely distributed in Tropical America.

13. RYNCHOSPORA JUBATA, Liebm. Vidensk. Selsk. Skr. V. 2: 254. 1851.
Rynchospora Mariscnlus Nees, Linnaea, IX: 297, hyponym. 1834.
Cited from Jamaica by Clarke as collected by Wilson. West Indies and Central and South America.

12. CLADIUM, P. Browne; Crantz, Inst. I: 362. 1766.
Type species, *Cladium jamaicense*, Crantz.

1. CLADIUM JAMAICENSE, Crantz, Inst. I: 362. 1766.
Cladium occidentale, R. & S. Syst. I: 284. 1817.

Common in coastal marshes. Ferry River (Harris 8632). Common in marshes throughout the West Indies and the southern United States.

Cladium Mariscus (L.) R. Br., of Europe, is in my opinion specifically distinct.

13. SCLERIA, Berg. Vet. Acad. Handl XXVI: 142. 1765.
Type species, *Scleria Flagellum nigrorum*, Berg.

A. Hypogynium present
- a. Margin of the hypogynium neither ciliate nor fimbriate
  - Ligule large, its margins scarious — 1. *S. reflexa*
  - Ligule short, ovate
    - Culm spreading, branched — 2. *S. secans*
    - Culm erect
      - Panicle reddish-purple; achene purple or purplish — 3. *S. melaleuca*
      - Panicle brown-green; achene white or whitish — 4. *S. pterota*
- b. Margin of the hypogynium ciliate, ciliolate or fimbriate
  - Achene 2 mm. long or less — 5. *S. microcarpa*
  - Achene 2.5-3 mm. long
    - Margin of the hypogynium finely ciliolate or nearly eciliate — 6. *S. cubensis*
    - Margin of the hypogynium densely long-ciliate — 7. *S. Grisebachii*

B. Hypogynium wanting
- Inflorescence glomerate-spicate — 8. *S. hirtella*
- Inflorescence of several loose elongated clusters — 9. *S. lithosperma*

1. SCLERIA REFLEXA, H. B. K. Nov. Gen. & Sp. I: 232. 1815.

Climbing or trailing. Hope (Harris 7084); Port Antonio (Fredholm 3338); submit of Bull Head Mountain (Underwood 3378). Haiti to Trinidad; Mexico to Brazil.

2. SCLERIA SECANS (L.) Urban, Symb. Ant. II: 169. 1900
Schoenus secans L. Syst. Ed. 10. 865. 1759.
Scleria Flagellum, Sw. Prodr. 18. 1788.
Scleria Flagellum nigrorum, Berg. Vet. Acad. Handl. XXVI: 144. 1765.

Jamaica, collected by W. Wright, according to Clarke (Sloane, I: *pl. 77, f.* 1). Northern South America.

3. SCLERIA MELALEUCA, Schl. & Cham. Linnaea, VI: 29. 1831.

Vicinity of Troy (Maxon 2874); banks, Content Gap (Britton 42); banks near Cold Harbour (Britton 882). West Indies, Central America; Tropical South America.

4. SCLERIA PTEROTA, Presl, in Oken Isis, XXI: 268. 1828.
Scleria pratensis, Nees in Mart. Fl. Bras. II: 179. 1843.

Moist banks and thickets and along streams, frequent at middle elevations. Near Gordon Town (Britton 8); near St. Paul (Marble 701); Troy (Britton 453); summit of Bull Head Mountain (Underwood 3409). Widely distributed in Tropical America.

5. SCLERIA MICROCARPA, Nees, Linnaea, IX : 302. 1834.

Scleria foliosa, Sauvalle, Ann. Acad. Habana, VIII : 154. 1871. Not Rich.

Scleria microcarpa var. *foliosa*, Clarke in Urban, Symb. Ant. II : 149. 1900.

Damp field near Port Antonio (Fredholm 3298). Not otherwise known from Jamaica. The var foliosa, Clarke, is said to differ from the species in the less ciliate margin of the disk, but this appears to be a very variable character, and I do not regard it as important in this plant. Widely distributed in Tropical America.

6. SCLERIA CUBENSIS, Boeckl. Cyp. Nov. II : 42. 1890.

Scleria microscarpa, Griseb. Cat. Pl. Cuba, 248, 1866 Not Nees.

Scleria microcarpa var. *eciliata*, Clarke in Urban, Symb. Ant. II : 149. 1900.

Moist rocky woods, Tyre (Britton 538); apparently not rare. Culms 4 m. long. Cuba; Haiti; Porto Rico.

7. SCLERIA GRISEBACHII, Clarke in Urban, Symb. Ant. II 151. 1900.

Scleria mitis, Griseb. Fl. Br. W. I. 578. 1864. Not Berg. 1765.

Marsh, Port Antonio (Britton 861). Plant 2 m. high. Porto Rico to Martinique.

8. SCLERIA HIRTELLA, Sw. Prodr. 19. 1788.

Summit of Bull Head Mountain (Underwood 3373); Jamaica Plants No. 2017 in Herbarium Public Gardens. Not otherwise known from Jamaica. Widely distributed in Tropical America.

9. SCLERIA LITHOSPERMA (L.) Sw. Prodr. 18. 1788.

Scirpus lithospermus, L. Sp. Pl. 51. 1753.

Scleria filiformis, Sw. Prodr. 19. 1788.

On hillsides in the xerophytic regions. Mona Hill (Britton 372); near Malvern (Britton 1902); Long Mountain (Harris 9510). Widely distributed in both New and Old World tropics.

14. UNCINIA, Pers. Syn. II: 534. 1807.

Type species, *Carex uncinata*, L.

1. UNCINIA HAMATA (Sw.) Urban, Symb. Ant. II : 169. 1900.

Carex hamata, Sw. Prodr. 18. 1788.

Uncinia jamaicensis, Pers. Syn. II : 534. 1807.

In forests at high elevations. John Crow Peak (Nichols 43); Clyde River Valley below Cinchona (Underwood 438); New Haven Gap (Maxon 2692); Cinchona (Shreve) road to Vinegar Hill (Harris 8435); New Haven Gap to Vinegar Hill (Britton 161). Distribution : Jamaica; Central America to Brazil.

15. CAREX, L. Sp. Pl. 972. 1753.

Terminal spike all staminate
- Perigynium long-beaked ... 1. *C. Underwoodii*
- Perigynium beakless ... 2. *C. hinnulea*

Terminal spike pistillate at base or apex or at both
  Spikes linear-cylindric — 3. *C. virescens*
  Spikes ovoid or oblong
    Perigynium glabrous — 4. *C. cladostachya*
    Perigynium rough-pilose. — 5. *C. scabrella*

Type species, *Carex pulicaris*, L.

1. CAREX UNDERWOODII, Britton. Torreya, V: 10. 1905.
Carex hystericina, Clarke in Urban, Symb. Ant. II 159. 1900. Not Schkuhr. 1806.

In sphagnum, Salt Hill Pond (Underwood 158); Petersfield Pond Guava Ridge (Shreve). Endemic.

2. CAREX HINNULEA, Clarke in Urban, Symb. Ant. II: 159. 1900.

The only specimen known of this species is preserved in the Goodenough herbarium, and its collector is not recorded.

3. CAREX VIRESCENS, Schkuhr, Riedgr. II: 45. 1806.

This common species of Eastern North America is also represented in the Goodenough herbarium by a specimen purporting to be from Jamaica, as recorded by Mr. Clarke.

4. CAREX CLADOSTACHYA, Wahl. Kong. Vet. Acad. Handl. XXIV: 149. 1803.

On banks and hillsides at high elevations. Cinchona (Shreve): Morce's Gap (Nichols 26; Britton 179). Mountains of the West Indies; Mexico to Bolivia.

5. CAREX SCABRELLA, Wahl. Kong. Vet. Acad. Handl. XXIV: 149, 1803.

Grassy banks and thickets. Between Chestervale and Silver Hill Gap (Britton 350); Mona Hill (Britton 363). Distribution: mountains and hills of Jamaica, Cuba and Haiti.

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BULLETIN

OF THE

DEPARTMENT OF AGRICULTURE, JAMAICA.

Vol. VI. JANUARY, 1908. Part 1.

EDITED BY

WILLIAM FAWCETT, B.Sc. (Lond.), F.L.S.,

Director of Public Gardens and Plantations.

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BULLETIN

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DEPARTMENT OF AGRICULTURE.

JAMAICA.

Vol. VI. JANUARY, 1908. Part 1.

CEARA OR MANICOBA RUBBER.*

INSTRUCTIONS FOR ITS CULTURE AND EXTRACTION OF RUBBER.

Owing to its easy acclimatisation and small requirements with respect to soil, Maniçoba will become a product of great importance, coming next to that of coffee, to-day so depreciated in its market value.

It requires however constant care and work.

Certain plants do not constitute what might be looked upon as capital, they ripen in a few months and then disappear, others like coffee, cocoa, and the Maniçoba represent a real income owing to their being long lived.

It is therefore on account of its great interest that we endeavour to make known some particulars of this most useful plant. Showing how its plantation should be made, how it should be treated, and the manner of extracting the Rubber. This is what we intend to do, making use of other works already issued, intending to add to them without damaging their clearness.

THE TREE.

The Maniçoba (Manihot Glaziovii) belongs to the family of of Euphorbiaceae to which also belong *Hevea brasiliensis* which produces the excellent rubber of the Amazon.

It grows not only in the interior, but also near the sea, and on mountain sides doing well in the pastures ranging betwoen 15° C. and 32° C.[59° F. and 90° F.] that is all over Brazil.

*Translated from Boletim: Sec. deAgricultura &c., Bahia, II, 2. Aug. 1903. We are indebted for the translation to Mr. D. A. Wetherall. *Editor.*

It is probable that its habitat covers a great part of the country periodically destroyed by droughr, from the banks of the river San Francisco to those of the Parahyba.

As to the condition of the soil in which it vegetates, it seems that the Maniçoba requires little, doing better in clay lightly mixed with sand.

The resistance of the plant to extreme drought, and at the same time its suitability to well irrigated and fresh earth cannot be explained.

On dry table lands of hard clay fine and luxuriant examples of the Maniçoba are raised.

Only on the sandy earths of beaches where the air is always damp the plant will vegetate quickly.

The hygrometrical state of the temperature will make the plant commence in the production of "latex," immediately after the winter, in the months of May and June. This flow of liquid, thin, and without consistence, is easily taken in "Flanders tin cans," in which it coagulates within 4 to 6 hours.

The amount which the dry season advances, rarefies the milky secretion, and from flowing it passes to dropping, coagulating rapidly on coming in contact with the atmosphere.

The latex is a liquid of glutinous consistency, made up of two elements, one liquid hardly coloured, the other very fine globules unequal, and of varying colour, which swim in the liquid. The circulation seems to be descending, and is favourable to the nutritive moisture; as to the form of these milky vessels, they are simple on ramified tubes, completely closed, of transparent walls, and without any appearance of punctuation or of transversal lines.

The latex which produces the rubber is different to the sappy or nutritive moisture of the plant and unless there be some means of invigorating the latex, then the belief of the explorators of the Seringueira or the Maniçoba, that the extraction of the milk weakens the tree is not unreasonable. The wood of the Maniçoba is spongy, light, white. The Cupim (insect of Brazil) attacks the wood as it does white pine. Gigantic trees do not resist the undermining by the Cupim for more than one year, and when the first high wind comes they fall, throwing sometimes to the ground the shoots, which take root and form new growths, at other times in the falling the seeds get scattered and quantities of plants spring up. The tree of the Maniçoba attains a height of 30 feet, it has a round shape and its leaves are similar to those of the Mamoa tree and of an ashy green colour.

PLANTING MANICOBA.

The seed is hard, flat, and smooth, nearly the size of a matured coca cob, of dark olive colour. Its hardness is extraordinary, resisting very heavy compressions, also its permeability to water, in which it may remain for a long time without putrefying or saturating. Without doubt because of this circumstance some planters lay them in a bed of sand, covering them with straw, thus parching them superficially. The hard scab of the seed dilates and splits, then on transplanting it grows easily.

This process is dangerous as it is liable to expose the germ of the plant, it is preferable to make a plantation in a nursery and transplant after, as is the custom with coffee trees.

Planting by cuttings does not offer any real advantage and can only be attempted with any result when the first rains of the year are over. For besides maiming the vigorous shoots of the mother plant, it is difficult for the cuttings to take root, and even after they have taken root, they resist but poorly any variations of the summer on the hills, but in damp districts ,which are never really wet, this system is perhaps better, so as to hurry the development of the plant, and consequently for its industrial profit. In any case it does not do for an extensive cultivation.

When care is taken to choose the seed, avoiding those which float on the water the plant comes up robustly, looking whilst young, like "Ricinus" [Castor Oil plant] or "Mandioca" [Cassava.]

During the first three or four weeks it grows from 8 to 12 inches, going ahead from then rapidly, attaining three or four metres in the first year, if the soil is really damp, as upon the sides of the mountains.

In the interior the development is slower, it is therefore planted in the summer so as to be nourished in the winter. Cattle like the young Maniçoba for forage, therefore it should be planted within closed places.

Some planters think that the Maniçoba does not require care, it being sufficient to make a clearance after the first year and onward, others think that this idea is quite wrong.

Snr. Adriene Delpeche says as follows :—

In the month of August I moved 20 roots, the first which were sown in a corner for experiment at one month old had attained a height of 15 centimetres. Half were planted in a piece of ground sown with millet, which was not weeded again. The other half were planted in a piece of ground which was always kept clean.

Result—The former are 30 centimetres [12 inches] high and are very fine. The latter measure upwards of 2 metres [6½ feet,] one being 5 centimetres [2 inches] in diameter having already vertical branches.

The enemies of the plant are the following :—

Immediately the plant shows the young stalk, ants of every kind, large and small destroy it, becoming most hurtful to every plant which is not in a nursery, where they may be carefully watched and guarded.

Then there is the sap which attracts the destructive insects to attack the slips of plants transplanted from the nursery, cutting is an instant innumerable leaves.

In the third year the cuttings of plants may be thinned as so may many of the seeds from fresh places. In the interior only with the fifth year or sixth year is it apt to produce, it being imprudent to tap before, owing to the poor resistance of the trunk. It has been observed that Maniçoba, thinned, even when young and tender, three or four years old, acquires strength quickly, distancing itself rapidly from its mates left alone.

The influence it has on the growth of the plant is as yet unknown, it should be an object of keen investigation.

The tree accommodates itself in a space relatively restricted not requiring more than 2 metres or 2½ metres [6½ to 8 feet] distance between one another. It bends little and its shoots grow vertically.

The agriculturist, H. Lember, wrote the following about the manner of planting Maniçoba :

To accelerate the natural germination, which lasts one year or more, it is necessary to scrape [file] the two rounded extremes of the seed, whose shell is very hard ; this operation requires great care so as not to interfere with the shoot.

The seeds are then planted in an open bed, at a distance from one another of about 3 inches, covering them with about ½ inch of soil, watering twice ordinarily if no rain. The bed should be well exposed to the sun, shade spoils the seed. At the end of 3 or 4 weeks there appear the first shoots, when they do not require any more special care, and they can be transplanted to their definite places when they have attained the height of one foot.

Those who do not care to go to this trouble of scraping the seeds, may leave them to soak in water for six days then sow them.

In this case the germination commences after 4 weeks and will be ended after three or four months. The transplantation may be made from cuttings of new sprigs, which easily attain roots so long as one eye is left above the soil.

EXTRACTION OF MILK FROM MANICOBA AND THE PREPARATION OF RUBBER.

The Commission appointed by the Government for the study of Maniçoba found in different zones of this State, in their report describes the following different methods employed for the extraction of the milk.

In the Maniçoba and in most of the plants of the family of Euphorbiaceæ, the latex contained in the bark by the laticiferous vessels from the roots to the leaves and fruit having the colour of sulphur or orange according to the exposure to the sun's rays, we noted a variety of the milk which was white.

At the branches and roots, the milk appears in abundance, principally the latter.

We encountered also latex in the pith.

PROPERTIES OF THE MILK.

When the bark is cut the milk exudes, giving out a smell of cyanogen acid, similar to Mandioca, coagulating rapidly under the action of oxygen, light and heat; it dries leaving on the bark a transparent layer which is easily detached in ribbon-like form, forming an excellent rubber. In mixture with water it coagulates in two parts, one solid, forming caoutchouc, or rubber; the other in suspension with it, giving it a milky colour, and consisting of albuminoid and other substances.

The milk ferments quickly; this we believe is due to the albumen, and giving off a smell of sulphydrate of ammonia, leaving the rubber intact, which gradually loses its colour through the development of the fermentation.

THE MOST APPROPRIATE TIME FOR TAKING THE MILK.

It is necessary to study the best time for tapping from four different points of view, principally :—

1. To obtain the greatest quantity of the product.

2. Not to damage the plant for future production.

In all the plants the circulation takes place with more or less activity in accordance with the seasons and the local climate.

In cold climates the sap remains paralyzed during the winter season. In hot and damp climates the sap is always in activity, increasing the circulation as the temperature rises, through the accumulation of the vapours in the atmosphere.

In hot and dry climates, part of the year the sap lies paralyzed on account of the liquid necessary to serve as a vehicle to the principal nutritives.

In our country we look upon two principal zones for the culture of Maniçoba, one hot and dry, the other hot and damp.

In the first, the circulation of the sap becomes active from October forward until April.

In the second, in spite of the rains in June, the activity takes place from September to January, the storm season.

It is in this season therefore, that the ascending movement of the sap takes place in the Maniçoba with all activity, carrying in the solution the principles which, on reaching the leaves have to endure the action of the oxygen so that after they are elaborated, they descend, renovating and creating new tissues, surcharging itself with the principles in excess, which are naturally expelled through the bark by ruptures or by the attack of insects. Therefore after one or two months the plant is replete with sap and with milk.

BEST TIME FOR COLLECTING.

The best time to commence taking "in the hot and dry zone" is between October and April, when the plant is in full vigour, and rich in "elaborate" principles establishing by the extraction of milk as if a continuous action were taking place by the defalcations and obliging the plant to refill this want, absorbing new elements and encountering with soil the water necessary for this substitution. This cannot take place from May to October, in which season owing to the want of water necessary to the vegetation, it cannot expel with ease the very thick principles contained in the laticiferous vessels.

In the "hot and damp zone" where the vegetation is always in activity, the best season for collecting should be in the summer, from September to January when the sap is "ripe" but in which season there is no want of water from the storms to give the necessary vehicle to the nutritive principles and to the materials which have to be excreted.

EXTRACTION OF MILK.

The only parts in the Maniçoba which can serve for the extraction of the milk are roots, and the branches, the latter, although they contain a great quantity of milk, present many drawbacks to the extraction, and endanger the life of the plant. These drawbacks are :—

1. The cuts, or any furrows made on the bark, interrupt at these points the circulation of the descending sap.
2. The great exposure to the sun aggravates these wounds by a quick drying up and by the rapid coagulation of the milk.
3. The difficulty in adapting the vessels.

In Maniçoba the tap root is the part which offers the greatest advantages to the production of milk, both in abundance, and the easy flow thereof, also by the employment of the best methods of extraction, and for giving an almost continuous supply.

DIFFERENT WAYS EMPLOYED IN THE EXTRACTION OF MILK.

First Process: Dig the earth at the side of the plant to the right or left, leaving uncovered the vital knot, and tap root, by the help of a knife or any other instrument of bone or horn, pointed, work below the vital knot or at the point of union of the branches and roots, on the tap root or secondary root. A small orifice on the bark made lightly without touching the wood, raise the bark or round off the orifice so as to leave it clean. Through this orifice will the latex flow and deposit itself in the cavity opened in the soil coagulating impregnated with earth thus losing in its value according to the greater or less percentage of earth.

Second Process: In the same way as the first, make the hole in the soil at the side of the plant, clear the tap root without making any mound so as to avoid any falling of the earth, this done, place at the bottom of the hole a trough or small basin made of clay or other earthenware, putting same close against the tap root, having done this make one or more scratches in the root, and the milk will flow, accumulating in the basin and coagulating without mixture.

Third Process: Extraction from branch. Although we are against the extraction from the branch, we explain the process which we think is the most wise, it being left to practice to ascertain which is the most profitable way.

Make small holes in different parts of the branch and by the dripping and running of the milk it is easily seen where to place the cups, then by means of a piece of string (perhaps it woul d be better to use zinc wire) hang the cups in such a way that they will be close up to the branch (when necessary) making a small cut in the bark so as to immerge the side of the small cup in such a manner that the greater part of the bark covers it, then make above the cup different furrows (the less the better) in such a manner that the milk will converge well thereinto. Cutting the tree unnecessarily should be avoided as it spoils the tree without giving any result.

In the Maniçoba (be it the root or branches) the smaller the orifice made in the bark the greater the production of milk, great care must be taken not to damage the wood.

Other methods employed to improve on the three descriptions given.

First Process: The use of water as a coagulator. In either of the processes fill the basins with water which will coagulate the milk in such a manner that sand and heavy substances will remain at the bottom of the vessel, and the light ones will float without adhering to the rubber, so that coagulating in the water it becomes separated from foreign bodies.

Rubber coagulated in water presents a splendid colour becoming pure and fresh, separating itself from that which gives the water a milky colour.

In spite of these good qualities we notice that the rubber continues to ferment, losing its fine natural colour, becoming dark and acquiring an unpleasant smell which obliges us to neutralize the fermentation, and preserving its qualities.

Second Process: In place of pure water use a solution of alum and with it fill the basins.

In our experience, we made a solution of alum in a glass vessel and scratching the tree we allowed the milk to fall drop by drop into the solution, on coming in contact with the solution it coagulated rapidly. Making the same effect as the drippings from a candle would make upon water, without changing its natural colour, producing a greater quantity of coagulation, and giving a rubber of the best quality and of orange colour.

Third Process: We also used chloride of soda (kitchen salt) making a weak solution, and as in the second process we allowed the milk to fall drop by drop, this time instead of coagulating it remained fluid, notwithstanding that the percentage of milk had been raised. Eventually it coagulated after a long time had elapsed, producing an excellent rubber the colour of sulphur.

The manner of adopting these two processes. Having to adopt either of these two processes you proceed as follows:—

Make a solution (if alum, sufficient to make a weak solution, if salt it should be saturated) with which the basins or troughs must be filled to receive the milk as in the other processes.

The quantity of the salt solution used may be used several times, when the basins are substantial so that they do not allow it to filter, they should also be covered so as to avoid rapid evaporation and the falling in of foreign bodies.

Which of these processes are preferable ? It is clear that it depends on the form you desire to adopt in the preparation of the rubber. Should you require to obtain the milk in great quantities so as to coagulate and press it, the salt solution should be used, but not having the requisites then the alum process may be used. One of the advantages of these two processes is the paralyzing of the fermentation, preserving in the rubber all its natural qualities without the disagreeable smell. They have also the advantage that the rubber can be taken to the press whilst fresh, forming a homogenous body and of any size required to be adopted.

(*To be continued.*)

THRIPS ON COCOA.

By H. A. BALLOU, M.Sc.,

Entomologist on the Staff of the Imperial Department of Agriculture

Thrips are small insects of the order Physopoda.

They are slender, with two pairs of narrow, membranous wings which are fringed with hairs. The metamorphosis is incomplete ; the mouth parts are intermediate between the biting and the sucking forms. The thrips of cocoa (*Physopus rubrocincta*) is from 1-18 to 1-25 inch (1-1·5 mm.) in length when full-grown. The adults are dark-brown or black, the young being pale-green or yellowish-green with a bright-red transverse band across the abdomen.

Thrips on cocoa was first investigated by the Imperial Department of Agriculture In November 1900, when Mr. Maxwell-Lefroy, then on the staff of the Department, visited Grenada in connexion with an outbreak of thrips. Mr. Lefroy paid a second visit to Grenada to continue his investigations of this pest in March 1901 (*West Indian Bulletin,* Vol. II pp. 175-190).

In December 1901, an article by M. Aug. Elot appeared in the *Revue des Cultures Coloniales,* entitled 'A new enemy of Cacao.' This gives an account of the occurrence of thrips, in Guadeloupe in 1898 and 1901. The article deals with the damage done to cocoa trees by thrips, the measures to be adopted for its supression, and includes a technical description of the insect by M. Gaird, who finding that it was new to science, proposed the name *Physopus rubrocincta,* by which it is still known. The occurrence of thrips in Guadeloupe is referred to in the *West Indian Bulletin* Vol. II. p. 288), where M. Elot's report is summarized. and the statement is made that 'the geographical distribution of thrips, as known at present, is Grenada, St. Vincent, St. Lucia, Dominica, Guadeloupe, and possibly Ceylon.'

* Reprinted from *West Indian Bulletin,* Vol. VIII p. 143.

Thrips injure cocoa by feeding on the leaves and pods. The mouth parts of thrips are intermediate between those of insects which bite off particles of food, which they chew and swallow, and those of insects which are provided with a proboscis by means of which they puncture the tissues and suck the juices of the plant or animal tissues on which they feed. Thrips have one large well-developed and one aborted or rudimentary mandible. By means of the large mandible they cut or puncture the surface tissues and then suck or lap up the juice or sap. Thrips feed on the underside of the cocoa leaves, and generally in groups or colonies. The position of these colonies is marked by a discoloured spot on the leaf. Examination shows that the green cells of the leaf have been destroyed by the feeding of the thrips. When the pod is attacked, the result is slightly different. The minute wounds inflicted by thrips in their feeding are healed up by the growth of the pod, with the production of a dark, corky material. When the pod has been badly attacked there is sufficient of this dark-coloured material to give the pods the characteristic mahogany or russet appearance which is characteristic of thrips' attack.

Thrips may be frequently seen with the abdomen elevated, bearing at its tip a drop of excrementitious matter which is from time to time deposited on the surface of the leaf or pod. When this dries, it forms a very small thin flake, which helps in the discolouration. This is however readily distinguished from the russet appearance.

The manner of egg laying of the cocoa thrips is responsible for other wounds to the plant. The adult female is provided with an ovipositor composed of two plates with saw-teeth edges. Although I have not seen the actual process of egg laying, nor seen it described, it seems probable that the eggs are deposited in cuts or incisions made by the ovipositor in the tissue of the leaf or pod.

If the leaves of a thrips-infected cocoa tree be examined at the time when the young leaves are coming out, it will be found that on the young leaves there are many adult thrips, while on the old leaves there will be seen few adults, and many colonies of young. Both young and old are found on the pods.

The explanation seems to be this : As the young leaves appear, the adult thrips migrate to them, there to lay their eggs. In this way, the eggs would be laid on the tenderest parts of the plant, and the thrips larvae would have the best possible chance for feeding. Probably, much the same habit prevails in the egg laying on the pods, although the period of growth of the pod is sufficiently long for the development of several generations of thrips.

The attacks of thrips on the leaves of cocoa are sometimes sufficiently severe to cause the leaves to fall off, but on the pods the effect seems to be very slight, the principal loss seemingly being from the picking of discoloured pods as ripe. When pickers have learned to distinguish between ripe pods and unripe ones which are discoloured by thrips' attacks, there is but little apparent loss from this cause.

Lefroy stated (*West Indian Bulletin*, Vol. II. p. 183) that the cocoa thrips is found on leaves and pods of cocoa and on leaves of cashew, guava, and Liberian coffee in Grenada, and on cocoa in St. Vincent, St. Lucia and Dominica. It is also found on cocoa in Guadeloupe, and I found it on wild guava and cotton in St. Lucia. As an additional note of interest, it may be mentioned that I have found both winged and wingless forms of adult female thrips. So far as I have seen, the males are always winged, and of a lighter colour than the females.

TREATMENT.

The treatment of thrips naturally falls under two heads, the application of insecticides for the direct control of the insects, and cultural methods for the improvement of the general health and vigour of the cocoa trees.

So far as thrips' attacks are recorded, these are always much more severe when they occur under certain conditions. In seasons of extreme drought and in localities where for any reason the health of the cocoa trees is impaired, thrips' attacks are liable to be experienced, while in seasons of favourable rainfall, and in cocoa orchards where all matters of good cultivation, such as draining, forking, pruning, and manuring receive careful attention, thrips are rarely prevalent.

From this it will be at once concluded that the matter of first importance is the health of the trees, and in the case of an outbreak of thrips, careful attention should be given to these points.

Rainfall conditions cannot be controlled, but by thorough attention to cultural practices, a condition of the trees and of the soil can be maintained which will make them much less susceptible to the effects of continued drought, on the one hand, and of excessive rainfall on the other.

Another operation that should be included under cultural methods consists in the destruction of all wild and useless trees growing in the vicinity of cocoa cultivations, which are likely to be infested by the cocoa thrips. The plants on which this insect is known to occur are, cashew, guava, Liberian coffee, and wild cotton. If any of these occur as valuable plants, it might pay to treat them for the destruction of thrips in the same way that the cocoa trees are treated.

If it becomes necessary to spray cocoa for the better control of thrips, one of the washes given herewith might be used.

On account of the extremely uneven and rugged character of the ground in many cocoa orchards, spraying could be performed only with difficulty, and since careful attention to cultural details will generally restore the trees to health, even in case of severe attacks of thrips, it may probably follow that spraying will be resorted to only in orchards favourably situated, and then only to serve as a check on the pest while the results of manuring, draining, forking, and pruning are being developed.

Insecticides with directions for preparing them, were given in the Appendix to Lefroy's report (*West Indian Bulletin*, Vol. II, p. 185) but may, with advantage, be reproduced for general information :—

1. *Rosin Wash.*

Powdered rosin	...	4 lb.
Caustic soda (77 per cent.)	...	1 "
Fish oil	...	¾ pint

Mix these, cover with about 2 inches depth of water and boil till all is dissolved. Then add water *very slowly* to the liquid, keeping it continually boiling until the whole is made up to about 3 gallons. This is stock solution. For use, add 6 gallons of water to 1 gallon of stock solution.

Amount of wash, 21 gallons.

2. *Kerosene Emulsion.*

Hard soap	...	½ lb.
Kerosene	...	2 gallons.

Boil the soap in 1 gallon of water till it is dissolved. Take it off the fire, at once pour in the kerosene, and churn the mixture with a force pump or syringe for ten minutes. This is stock solution. Add 9 gallons of water to 1 gallon of the stock solution.

Makes 30 gallons.

3. *Kerosene Emulsion with Whale Oil Soap.*

Use 1 lb of whale oil soap in place of ½ lb. of hard soap as in No. 2.

4. *Rosin and Whale Oil Soap Compound.*

Rosin	...	4 lb.
Washing soda	...	3 "
Whale oil soap	...	10 "

With the rosin and soda make 4 gallons of rosin compound stock solution as above. Stir the whale oil soap in 5 gallons of hot water : mix the two while hot. This is stock solution. To every gallon add 4 gallons of water. An alternative method is to make the rosin compound stock solution. For use, mix 1 gallon with 10 gallons of water and stir in 2½ lb. of whale oil soap. Every 45 gallons of wash should contain the above ingredients however mixed.

Of these I should recommend Nos. 1 and 3 as likely to be most effective.

RUBBER CULTIVATION IN JAMAICA.*

By T. H. SHARP.

Now that rubber cultivation has been taken up seriously in Jamaica by several planters, I have compiled the following short notes with the view of rendering assistance to all intending planters.

There are so many varieties of rubber which appear in different countries to thrive best at various altitudes and to yield according to varied conditions, that it would appear to be impossible to lay down any fixed advice in the matter as to what we should do in Jamaica as to the choice of kinds for planting. It may be possible, however, by comparing results obtained in other countries, to be able to advance upon reasonably sure lines to suit our conditions.

For the present, planters should confine their operations as to laying out plantations to as few varieties as possible, but at the same time to experiment with as many other varieties as is convenient on a small scale. Such experiments should be laid out in different localities possessing varied soil and climatic conditions.

The plantations should be commenced with *Hevea brasiliensis, Castilloa elastica,* and *Forsteronia floribunda.* Other varieties might be tried, but it is probable that the above-mentioned rubber-producing plants might be relied upon for cultivation in certain districts in Jamaica.

SOILS.

The lands of Jamaica may be devided into the following four classes:—

1. High altitude lands from 2,000 to 4,000 feet mostly of limestone formation, covered with trees, rich in humus, naturally drained, with plentiful rainfall.

2. Lower altitude lands from 1,000 to 2,000 feet, good rainfall, generally rich, but now being more largely cultivated.

3. Lands from 400 to 1,000 feet in altitude, fairly well denuded of forest, severely injured by running fires, and populated more thickly than the higher lands. This section would possess but small areas that could be conveniently given up for rubber cultivation.

4. Lands extending from sea-level to 500 feet. The deepest and richest lands of the island, with well-defined seasons, rainfall less than the higher altitudes. This land, being deeper and richer, is more retentive of moisture.

Each altitude enjoys its peculiar advantages and varies as much in its class of labourer as it does in its soils and climate. Any fixed advice as to the cultivation of rubber or of any other plant cannot, therefore, be given so as to apply to the whole island. It is only by comparisons and experiments that the best results can be obtained in each locality.

Unfortunately, rubber takes a long time to produce, and

* Reprinted from *West Indian Bulletin* Vol. VIII p. 191.

must be cultivated on a fairly large scale to ensure success. It is impossible, therefore, to commence experiments with rubber now, if we mean to keep pace with other parts of the world.

I can only in this short paper make a mental résumé of the valuable articles which have been written by the Director of Public Gardens and by the Secretary of the Agricultural Society, as well as by several authorities on rubber cultivation and to embody their views and conclusions with the small experience with experiments I have carried on for the past year.

VARIETIES OF RUBBER.

Castilloa elastica, assuming that the correct variety is obtained and that seeds have been taken from latex-producing trees, can safely be planted in any district where the breadfruit thrives.

This rubber-producing plant, it has been said, will die back when severely tapped if it is grown upon land unsuited to it. I am inclined to believe this, because it is such a luxuriant grower and is not as hardy as the Para rubber tree. I note that the Para stands transplanting much better than Castilloa : but on the other hand, under favourable conditions, Castilloa will grow larger and yield considerable quantities of latex in a country that may be called its natural habitat. Plants scattered about in the bush several years ago and forgotten, have survived. To-day from one end of Jamaica to the other may be found some Castilloa trees that compare favourably with trees grown in any part of the world in respect to size and quality of latex.

The advantages that Hevea has over Castilloa in this country, are its hardiness, and its 'wound response' stimulating flow of latex in tapping. On the other hand, Castilloa, under favourable conditions, yields earlier, forms better shade for cocoa, and eventually should give more latex per acre than Hevea. More care will have to be taken in the tapping and in the selection of the soil before planting.

In dry districts, Hevea would probably thrive better than Castilloa, for it is a very hardy plant.

The Ceara plant (*Manihot Glaziovii*) has been recommended as suitable to dry districts, but the difficulty in tapping, slow growth, small yield, and value of latex place it, to my mind, as being quite unfit for this island, where land abounds which can produce better varieties.

One of the serious points to be dealt with in the cultivation of these two varieties is the production of seedlings. From the time the seed germinates no check should be given to the plant, especially in the case of the Castilloa. In Jamaica, there is quite sufficient large healthy full-bearing milk-yielding Castilloa trees to furnish all the seedlings required. These trees drop their seed in July and August and it should be gathered daily and planted out at once in boxes to germinate Small boxes conveniently holding 100 plants each should be used. Bamboo pots although easily portable should not be used, as they cause the roots of the plant to grow unnaturally, and the plants are apt to sicken. Experiments this year showed that seeds planted in boxes produced larger plants than those grown in bamboo pots, in about half the time. The seeds from the same tree and the same earth were used in each case. Several of the seedlings grown in the bamboo pots became so sickly and weak that they had to be thrown away.

The best time for planting out Castilloa would appear to be after the first rain at the end of September or early part of October, and during the first and second week in April.

Castilloa seed is of such a perishable and soft nature, and the seedlings are so delicate, that it requires a good deal of skill and attention to preserve them in a healthy state ready for planting.

This perishable seed, produced in July and August, cannot be successfully grown to a sufficient size to plant out in the field by the end of September. A few of the earlier bearings will do so, but the bulk of the seedlings will not be strong enough in time for planting, and, consequently, will have to be kept back until April. They may become too large for the boxes and will therefore have to be transferred to beds in a nursery,

Hevea seed cannot be obtained in this country, and has to be imported. Under favourable conditions, if a planter tests his Hevea seed and finds that it germinates well, it would probably be advisable to put about three seeds directly into the earth where he intends to grow plants permanently. If they all grow the weakest should be removed and transplanted.

Castilloa should be planted on the group system 20 feet apart three plants being put into each hole so as to ensure an establishment of absolute healthy trees. As soon as the plants have taken root, and have grown about 3 feet high, one plant should be removed, and at the end of four years the weakest of the remaining two might be so heavily tapped as to bleed it to death. This would give a small return and would ensure the permanent establishment of one healthy tree, and so far from retarding or injuring the tree would help it, as Castilloa appears to succeed very well in group planting provided it is given a fair area between each hole.

Hevea should be planted 20 feet apart, but not in the group system. It naturally grows straight. and therefore differs from Castilloa, which is inclined to throw out lateral branches before it reaches a good height.

Hevea should do best on alluvial lands, but I see no reason why it should not also thrive on any ordinary land that is sufficiently rich and has a fair rainfall.

With regard to the *Forsteronia floribunda*, we have in Jamaica a natural rubber-giving vine that abounds over almost all our limestone formations. It is a climber, and can be found plentifully at altitudes from 200 feet to 4,000 feet.

Hitherto the impression has been that the rubber from this vine was of inferior quality, and the vine could only be found here and there in isolated places. Investigations by officers of the Jamaica Agricultural Department have shown, beyond doubt, that this vine grows indigenously over many thousand acres of our land. It yields rubber of an exceedingly high quality that is free from resinous matters.

It trails along the ground for about 20 to 30 feet and then mounts the forest trees.

I have given this plant a good deal of attention, and have made and submitted its rubber to experts. They have pronounced it as being highly satisfactory.

The cultivation of this rubber-producing plant could be carried on very easily. Enter the bush and under-wood, gather your cuttings direct from the present growing plants and place them into the ground in rings around standing trees. They will grow readily and run on the trees. The bleeding of them would be exceedingly simple. By cutting a small slice on the side of the vine by means of a sharp instrument, the milk would run readily into a pan placed beneath.

This vine grows readily on the kinds of land that are too rocky for either Hevea or Castilloa. It has been said that because the vine is a climber it would not lend itself readily to cultivation but it should be comparatively easy to establish, if these vines are planted 6 feet apart in the woods, from 1,600 to 1,200 vines per acre.

A single vine will often yield sufficient milk from a single tapping to give an ounce of rubber, and assuming you tap the vines several times in a year, the yield would be considerable. The collection of rubber from vines is now being carried out largely on a commercial scale in other parts of the world and there should be no reason why this rubber-producing plant could not be successfully cultivated for the same purpose. The demand for rubber is exceeding the natural supply. Cultivations are springing up on every side, and there are many parts of Jamaica that could be made to produce as good rubber as can be obtained from other parts of the world.

PINE-APPLE GROWING IN THE WEST INDIES.*

By G. L. LUCAS.

The growing for export of pine-apples in the West Indies has never been successfully accomplished, except in the Bahamas, and in the island of Cuba.

The Bahamas for many years were large producers and exporters of pine-apples. All the fruits were sent to Baltimore in schooners in bulk to the canning factories, but of late years the industry has steadily failed, until now the shipments from these islands have become small.

* Reprinted from *West Indian Bulletin* Vol. VIII p. 151. For previous article by Mr. Lucas see Bulletin of Dept. of Agriculture, Vol. V. p. 41.

The Bahama Islands are composed of coral rocks, and the little soil at any time could be only found in the crevices of these rocks. Repeated plantings have exhausted what little soil there was, until now the planter in these islands is confronted with the problem of how to continue an industry that at one time proved so profitable.

The Government some years ago passed a law forbidding the exportation of any more pine-apple plants, hoping by this means to save the declining industry, but government laws have failed, because it was the exhaustion of the soil and not the loss of plants that was responsible for the decline.

Florida, in 1883, produced no pine-apples except on the outlying keys from which, like the Bahamas, the produce was shipped in bulk to Baltimore in schooners to the canneries. In 1884, the few settlers on the eastern mainland of Florida began the experimental planting of suckers that were obtained from the Florida Keys. Later, as the business grew and the demand for plants increased, the Bahama Islands were drawn upon and many hundreds of thousands of plants found their way to Florida to commence the industry that to-day forms one of the principal sources of revenue of that state.

The Florida pine-apple grower in all these years has had many discouragements to contend with, and aside from poor soil, the greatest enemy has proved to be frost. With this menace constantly confronting it, the business has been kept in check and no doubt will always be kept within certain bounds.

Cuba produces more pine-apples than Florida, the Bahamas, and the West India Islands combined, and the export of this fruit is increasing rapidly every year. It pays the planter in Cuba to grow pine-apples because of the extremely fertile soil, and the frequent, cheap and quick transportation to the United States, where a reduction of 20 per cent. on the duties is allowed on this fruit. Little success could be expected from shipping fruit from the British West Indies to England with the present unsatisfactory means of transportation, for the reason that the journey is too long, freight rates are too high, and private shipments generally receive indifferent care by the transportation companies.

Jamaica enjoys direct communication with England by a subsidized line, but this line gives the greater amount of attention to the carriage of bananas, so as to fulfil its contract with the English and Jamaican governments. Private shippers, therefore, receive secondary consideration, and experience in the past has shewn that losses are frequently incurred. During the past three years, such have been the experiences of those who have made earnest and repeated trials of private shipments that now no individual shipments are made in the fruit line from Jamaica.

Probably the best way of establishing a profitable pine-apple business in Jamaica would be to build canning factories to utilise the fruit on the spot. This can be done by growers combining and erecting a modest factory. Encouragement should then be offered to others to grow good fruit, which would be purchased for cash delivered at the factory, at a price that will pay the grower handsomely and allow the factory to earn a fair percentage on the investment. There is always a good demand for canned pine-apples in England, and large shipments of such goods are sent from Singapore every year to both London and Liverpool. If Singapore can make the canning of pine-apples a profitable business, with its cheap labour, there are other advantages that are enjoyed by the West Indies that the East can never hope to have. I think that if this subject be given the consideration it deserves, a new industry that can be depended upon to yield revenue to many of the West India islands would be the result.

A canning factory was erected in Jamaica in 1905, and it has given successful results. Many obstacles were encountered before the business could be made profitable ; mistakes were made and losses incurred.*

Another canning factory is now being erected in Trinidad, which may prove a profitable investment to those who have had the courage to lay out their money in a new enterprise. Every encouragement should be given the promoters by the planters in Trinidad who if they planted largely, would find ready sale for all their fruit at remunerative prices.

ESTABLISHING FIELDS.

To establish a pine-apple plantation needs some knowledge as to the proper methods to follow, and although Cuba produces millions of fine pine-apples, the method of laying out fields in Cuba are somewhat crude.

The Cuban method is to plough the land, turn up ridges about 3 feet apart as for sweet potatoes, and then to plant the pine-apple suckers along the top of these ridges about 8 inches apart in the rows. This method of planting is not to be recommended, for the plants are too far apart between the rows and too close together in the rows. The plants receive no support from one another, and when they fruit, the weight causes them to turn over. In consequence, the fruit becomes sunburned, the plants become uprooted, and the suckers find much difficulty in striking their roots into the soil. The fields soon deteriorate, as the sun bakes the soil and burns the roots of the plants.

The Cuban possesses an idea of drainage but his understanding of this necessary part of pine-apple cultivation is very crude, and it might be anticipated that if he only knew more about the proper cultivation of pine-apples, much better results would be obtained.

After twenty-four years devoted to the growing of pine-apples both in the sandy soils of Florida where no drainage is ever

* The late earthquake destroyed all the stock of goods that had been made up, which happened to be stored in the city of Kingston.

needed, and a long experience in Jamaica where the soils are heavy and where thorough drainage is absolutely necessary, I have to make the following observations for the guidance of those that are about to embark upon the cultivation of pine-apples :—

The prospective pine-apple grower should select his soil with the greatest care. The best soils are probably light loams, rich in humus. A heavy cold soil, or soil inclined to become sticky or gummy in wet weather should never be chosen. Look for what is a good scouring soil containing sufficient sand to make it pliable at all times, and it is advisable that it should slope gradually. Hilly parts should be passed by.

First the land should be thoroughly ploughed, then cross ploughed, and harrowed until it is thoroughly pulverized and freed from the smallest lumps. A wheel or disc harrow is the only tool that can get such land into proper condition This should be followed by an Acme harrow which will smooth and level the land. A tooth harrow should not be used, for this tool only pulls out the grass and weeds, and brings to the surface trash, which is best left in the soil to assist in enriching the land.

After the land has been prepared, mark off with a line for trenches. These trenches should be 14 inches wide and 14 inches deep, and should follow the slope of the land in order to afford proper drainage. The trenches should be 12 feet apart, they should be made perfectly straight and in line, and all soil taken from them is best thrown equally on both sides in order to build up the beds. This soil then, should be raked towards the centre of the beds and brought somewhat higher in the middle than at the sides, so as to allow a difference of about 6 inches between the height in the middle and that along the edge of the trenches. A fine-tooth steel rake should be used and the beds should be made as smooth and even as possible.

When the trenches and beds have been completed, mark off each bed into checks 18 x18 inches. This will give about nine rows along the beds. The cross checks should be made regularly except at intervals; two lines can be admitted so as to allow for paths. These marks should be made with a wooden marker and they should be perfectly straight to facilitate subsequent cultivation. The plants are then dropped at the intersection of each mark. They are then ready for the planter, who with a good strong trowel, follows along and sets the plant at each cross mark at a depth of one-fourth of their length. This depth of planting is to be recommended no matter what the length of a plant. If planted too shallow, they will not become sufficiently rooted, and heavy winds will blow them out of the ground; and if planted too deeply they are liable to be smothered by having the soil filling the hearts. Suckers or slips that are longer than 12 inches can be lopped off and brought down to 8 inches so as to facilitate rapid planting and to prevent their being blown out of the ground before they have taken root. If the suckers are not planted in strictly straight rows each way, they should be pulled up and planted again. If the labourer who plants them is charged for his mistakes, he will be more particular in future as to getting them perfectly straight.

CULTIVATION.

After the plants have been set out, they can be left alone for five to six weeks to allow them to become well rooted, unless weed growth becomes too vigorous. If weeds become at all prevalent, the beds must be hoed without delay, for during this early stage of growth weeds and grass should never be allowed to grow or get ahead so as to cause the plants to receive a check, as plants that have their growth checked at this early stage rarely, if ever recover.

Nothing but a push or scuffle hoe should be used in the cultivation of pine-apples, A special hoe, 10 inches wide and about 3 inches deep and sharpened on both sides with a handle about 8 feet long, has proved a very useful tool.*

The hoer should be a careful worker and should be instructed to stand in the trenches between the beds. He should never be be allowed to walk among the plants or to trample down the soil. The usual method of cultivation is to hoe from each side, pushing the hoe between the plants, gauging so that the hoe will cut about ½ inch beneath the surface of the soil so as to cut off every weed or piece of grass showing. Great care should be taken not to disturb the plants by knocking the hoe against them, because when they are just beginning to take root the slightest jar will check their growth.

In about six weeks after the suckers have been planted, they should, under favourable conditions, be showing growth. The best time to plant is probably during June, July, and August. It is frequently a difficult matter to procure plants before July, for the reason that suckers and slips are hardly ripe enough for planting. If gathered immature they are liable to rot.

After the plants show growth, an application of tobacco dust will prove highly beneficial, This dust contains 6 to 8 per cent. of potash, 3 to 4 per cent. of ammonia, and about 2 per cent. of phosphoric acid. Besides being a good fertilizer, it is an insecticide, and this makes its use doubly valuable. The best method of applying tobacco dust is to have the labourer handle it in buckets. He carefully walks among the plants and drops a pinch of the dust into the heart or bud of each. This, of course, necessitates walking on the beds, but it can be done with care and the beds can receive another hoeing afterwards. Dust is often applied before hoeing, so that the beds are left in a good condition.

Tobacco dust should be applied at intervals of two to three months in small doses, each application requiring about 600 lb. per acre if carefully distributed. Such applications can be continued until three months before flowering of the plants, when all applications should cease. As pine apples generally blossom

* Such hoes may be obtained from Messrs. Parkes, Birmingham.

or show fruit in January, no dust should be applied after October.

GATHERING THE FRUIT.

In twelve to fourteen months fruit should be in proper condition to pick, and if intended for foreign markets, should be gathered green but perfectly full. Experience can be the only guide in picking for shipment, so that a good colour may be obtained, for if pine-apples are picked too green they will never assume a good rich colour. The method practised is for a picker to go into the fields followed by another man who should have a wicker basket of about one or more bushels to carry the fruit. This man takes each pine-apple from the picker and carefully places it in his basket. When the basket is filled, it is carried either to the packing house or placed in a spring cart or waggon padded with bagging to prevent the fruit from being bruised. It is thought that many growers in cutting the pine-apple from the plant with about 2 inches or more of stalk attached to the fruit make a mistake; for this stalk in a few days, becomes sour, and decays the fruit. The better method probably is to snap the fruit from the stalk. With a little practice this can be done without breaking the stalk, by gently pressing the knee upward under the pine-apple, and with the hand bend the fruit inwards until it snaps from the stalk. (A few slips removed from the side towards which the fruit is bent will cause the pine to snap from the stalk easier, but in no case remove all the slips during the early or later growth of the pine-apple, because they protect the fruit from the sun. Besides, the slips when allowed to grow the proper length are well worth planting and form a valuable asset to the planter.)

PACKING.

When the fruit is delivered at the packing house, it is carefully piled not more than three pines high, on tables or on a clean floor. It is left overnight to cool off before being wrapped. The paper used for wrapping should be tough and strong, but not too thin or too thick. After the pines are sufficiently cooled, they should be carefully wrapped and placed where the packer will be able to get to them without moving from the crates. The crates hold twenty-four, thirty, thirty-six, forty, and forty-eight, according to size (forty-eight size being very small are seldom shipped). Each pine-apple is handled separately, and they are placed head and tail (or top and bottom) alternately in the crate. After the package is filled, the fruit should project about 1 inch above the sides of the crate, and the slats are then nailed. In this operation the slats should be gently pressed down with the knee and never nailed until each slot is firmly pressed down on the sides of the crate; otherwise, bruising of the fruit will result. Too much care cannot be taken in packing and handling all kinds of fruit.

Freight on all shipments must be prepaid, and proper bills of lading should be taken out; shipments for Canada must be accompanied by delaration made out in triplicate on regular forms copies of which can be obtained either from agents in Canada or from the Imperial Department of Agriculture.

DISEASES.

The pine-apple plant is not affected with many diseases. Blight affects the Ripley and Queen family more than any other kind, and when established is very difficult to cure or to check. It sometimes spreads through fields with great rapidity, and within a short time healthy looking fields may present a withered and ruined appearance.

Black heart usually affects the Ripley and the Queen family, and can rarely be detected until the pine-apple is cut. Black spots are to be found in the fruit that utterly ruin it. The Ripley is extremely liable to this disease.

VARIETIES.

The *Abbakka* is probably the handsomest pine-apple grown, but its quality is very inferior. It is watery and flavourless, and a poor shipper.

Smooth Cayenne—This is the St. Michael's pine-apple, and the only variety that sells in the London market for the highest prices. This variety cannot be grown with success in the West Indies. It has repeatedly been tried at Jamaica, but has eventually been abandoned.

The Smooth Cayenne will not endure the severe heat of the West Indies, and whilst some few good specimens have been grown, the cultivation has proved a failure. It is a watery pine-apple and is a poor shipper. Its fine appearance only recommends it. It is essentially a hot-house pine, and the expense and great care incidental to its culture in the Azores compels the grower to receive high prices for his fruit.

Sugar Loaf.—This variety is of fine quality, but is too tender to ship with safety. A few grown for local consumption and home use are, however, acceptable. There are other sorts that are misnamed 'Sugar Loaf' in Jamaica, and few persons really know a genuine pine of this variety, but when once shown, the difference between it and other misnamed varieties becomes apparent

Black Pine or Black Jamaica.—This variety is so worthless that a description is hardly necessary. Suffice it to say that it is a course, ugly, watery, and insipid fruit that does not even deserve consideration, except to warn the inexperienced grower against planting it.

Antigua.—This pine-apple is well thought of in Antiga but it is too small, and possesses nothing to recommend it in any way for shipping purposes.

Sam Clark.—This fruit presents a pretty appearance, as it has a tremendous top, but it is only of inferior quality, being small, watery, and insipid.

Red Spanish (erroneously named in Jamaica, *Bull Head, Cow Boy,* etc..)—This variety, although subject to slight variations, can be safely classed under one head ; namely, Red Spanish. This pine-apple is the oldest variety and most extensively grown in the world : it forms the entire crop of Cuba, Florida, and the Bahama

Islands, besides growing wild in many of the islands in the Caribbean Sea. It has proved the only profitable pine-apple to grow, and those contemplating taking up the growing of pine-apples will do well to bear this fact in mind. It is the only kind that sells for remunerative prices in the markets of the world. It is a splendid shipper, and, whilst not of finest quality, it possesses a good appearance, and is of a large size. Large crops of marketable fruit may be depended upon, for the plants are practically free from disease. and are vigorous and very prolific in slips and suckers.

CONCLUSION.

The growing of pine-apples is a plesaant occupation, and if followed with care and proper attention, success is not uncertain, if adequate transportation or a local demand, such as canning factories, not too distant from the plantation, can be depended upon. Growing pine-apples to be sold at ½d per lb. delivered at the factory will pay the planter fairly well, and will allow the factory to earn a reasonable percentage on the investment.

Sixteen thousand pine-apple plants can be planted on 1 acre, and if the business is properly managed, the fields should produce 80 per cent. fruit in from fourteen to sixteen months. Each pine-apple should average not less than 3 lb., and if the grower is so fortunate as to have a large local demand for his fruit, he will not be under the necessity of going to the expense of buying crates, wrapping paper, nails, and pre-paying freight on his shipments. The business of consigning fruit is not as satisfactory as it should be, and the unfortunate planter is compelled to submit to many an injustice; but in Cuba and Florida, 75 per cent. of the pine-apples and oranges are sold for cash in the fields or in the groves at a contract price, the buyer taking all risk of shipment.

BOARD OF AGRICULTURE.

EXTRACTS FROM PROCEEDINGS.

The usual monthly meeting of the Board of Agriculture was held at Headquarter House on Wednesday, 11th December, 1907 present: Hon. H. Clarence Bourne, Colonial Secretary, presiding Hons. Director of Public Gardens, the Island Chemist, the Super intending Inspector of Schools, and Messrs. D. Campbell, D. G, Murray, E. W. Muirhead, Conrad Watson and the Secretary.

Cotton.—Letter from Messrs. Kerr & Co. referred by the Governor, the Secretary's minute, which had been circulated, with members' remarks thereon. Mr. Watson snbmitted a paper he had written on "The Cotton Industry in Jamaica," which was read. Mr. Murray moved that Mr. Watson's paper be sent to the Governor as the opinion of the Board on the whole matter of cotton growing here. Mr. Muirhead seconded; and this was agreed to. Mr. Murray said that Mr. Watson had made cotton growing pay handsomely on a large scale in Montserrat, he had more experience, therefore, than any one in Jamaica, and if cotton growing was to be established in Jamaica, advantage should be taken of his experience. It should be arranged, if possible, for the Agricultural Instructors to be instructed by him in this particular direction.

The Board thought it desirable that if it were found possible to do anything for the cotton industry on a substantial scale, arrangements should be made to secure the assistance of Mr. Watson.

Teachers' Agricultural Course.—The Secretary read letter from the Superintending Inspector of Schools intimating that he was advertising the agricultural course for teachers to begin at the Mico on December 30th and last four weeks.

Agricultural Course at Laboratory.—The Secretary read copy of letter from the Colonial Secretary to the Island Chemist intimating the Governor's approval of the examination being held as usual in December, and in view of the three students for 1907 not having yet been taken on, they be now taken on in addition to the three students for 1908, and authorising an increase of £72 to the usual annual provision in the estimates for next year, subject to this provision being voted by the Legislative Council.

The Secretary submitted the following letters from the Colonial Secretary's office :—

Estimates Director Public Gardens—Forwarding the estimates of the Department of Public Gardens and Plantations for 1908-09 for consideration. These were directed to be circulated. In connection with these the Board recommended a small increase from 6/ to 7/6 per week to the second Assistant in the Herbarium on the ground of increased usefulness, as asked for.

Permanent International Sugar Convention.—Forwarding copy of a circular despatch from the Secretary of State for the Colonies relative to the proceedings of the Permanent Sugar Convention.

Agricultural Conference.—Intimating that the West Indian Agricultural Conference would be held at Barbados from January 14th to 21st next, and stating that the Governor would be glad to receive the recommendations of the Board as to the advisability of sending a Government delegate or delegates to the proposed conference.

It was agreed that as the sugar industry was expected to form the special subject of discussion at the conference, some competent representatives of the sugar industry be sent, and to adopt the nominees of the Westmoreland, and the Northside Sugar Planters' Associations as the representatives of the Board.

The reports from the Director of Public Gardens were submitted as follows :—

(a) Hope Experiment Station.
(b) Instructors' Reports and Itineraries.
(c) Letters from Mr. Cradwick asking for a supply of spraying materials for Mr. Mennell to conduct some experiments in Hanover. The last was referred to the Chemist.

The Chemist's reports were submitted :—

(a) Superintendent of Field Experiments.

(b) New arrangements for Junior Assistants.

An application by the Secretary for a new press to hold papers in place of the one broken in the earthquake was held over to see if there were sufficient funds.

The Secretary submitted memorandum intimating that he had commenced supplying some of the Public Institutions with native arrowroot got from Lamb's River, but was handicapped for store room, as he was obliged in the initiation of this source of supply to handle the stuff. He was directed to see if he could arrange for the Island Medical Stores to store it when necessary.

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BULLETIN

OF THE

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Vol. VI. FEB. & MAR., 1908. Parts 2 & 3.

EDITED BY

WILLIAM FAWCETT, B.Sc. (Lond.), F.L.S.,

Director of Public Gardens and Plantations.

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Vol. VI. FEB. & MAR., 1908. Parts 2 & 3.

THE PRESENT STATUS OF THE NITROGEN PROBLEM*.

By A. F. WOODS.

Pathologist and Physiologist and Assistant Chief of the Bureau of Plant Industry, U. S. Dept. of Agri.

INTRODUCTION.

One of the greatest problems in the maintenance of soil fertility for the maximum production of crops is how to secure and keep a sufficient supply of available nitrogen of the least cost. For most of our arable land it is now pretty well agreed that this is a problem of bacteriology, with the soil as a culture medium. As in most other great problems, nature and practical experience have pointed the way to its solution. Many of the standard practices of cultivation, crop rotation, etc., which have developed from experience have very important relations to bacterial action in the soil. In fact, the true relation of many of these practices can be understood only from the standpoint of bacterial activity. It remains for science to explain, systematize, and improve practice, placing conditions more accurately under our control.

The sources of nitrogen supply are, first, the nitrogen already contained in soils; second, that supplied to the soil by the decay of organic matter; and third, the fixation of atmospheric nitrogen.

THE DIRECTLY AVAILABLE NITROGEN CONTENT OF SOILS.

The nitrogen in soils is of two types: (1) The ammonia, nitrites, and nitrates, in which forms it is available to crops; and (2) the nitrogen locked up in organic matter and not directly available.

* From the Yearbook of the U. S. Department of Agriculture, 1906.

The nitrate nitrogen (nitrogen in the form of nitrates) is in most soils present only in small quantity. This supply is quickly taken out by crops or washed out by rains, and if it is not renewed by the action of certain bacteria on the nitrogenous organic matter in the soil or from the atmosphere by other bacteria it must be added directly as nitrate of soda or nitrate of potash, or some other manure must be used containing directly available nitrogen, Manures containing directly available nitrogen are very expensive. The best of these is nitrate of soda, and at the present rate of use the known supply will be exhausted in less than fifty years. More than 1,543,120 tons were used in 1905. Prof. Sylvanus P. Thompson has reiterated in a recent address* the prophecy of Prof. William Crookes, that we shall have a wheat famine unless the yield per acre, averaging for the whole world 12 7-10 bushels, can be increased. He believes with Crookes and many others who have studied the question carefully that the supply of nitrates is the most important factor in the situation, and it is important not only for wheat but for all other crops. We are not, however, as Professor Thompson seems to believe, dependent on the electrical method, briefly discussed later in this paper, for obtaining this supply. The larger part of the nitrogen required in agriculture is now and will always be obtained from the atmosphere through the agency of certain soil bacteria. By careful study of these organisms and their requirements we can greatly increase their activity. The electrical method, however, will be useful in supplying a part of the immediately available nitrate needed in intensive agricultural operations.

THE DECAY OF ORGANIC MATTER.

The organic matters which are added to the soils in manures and in vegetables and animal remains must go through certain processes of decay before the plant foods they contain become available to crops. Bacteria and fungi of various kinds are the active agents which bring about these changes. Decay is not a simple process, the same in all places and under all conditions. The process varies when the same materials under the same conditions are acted upon by different organisms or groups of bacteria which produce it.

In general, organic materials contain two classes of compounds ; (1) The nitrogenous or albuminoid compounds, like flesh and blood of animals and the protoplasm of plant cells ; and (2) the non-nitrogenous compounds, the carbohydrates (such as sugars, starches and cellulose) and the hydrocarbons, as fats. The first class contains the nitrogen formerly taken from the soil as nitrate by some plant, but which in its highly organized form is unavailable to crops until converted into ammonia or nitrate again by certain bacteria. The compounds of the second class serve as food for certain bacteria which are able to obtain their nitrogen from the air and will be discussed later.

*See Nature, vol., 73, p. 355, 1906.

The highly organised nitrogenous materials above mentioned, in soils containing a good supply of phosphates, potash, carbonate of lime, and air, moisture, and the right kinds of bacteria, are first modified or digested into soluble peptones by a class of bacteria which secrete a peptonizing ferment. *Bacillus tumescens*, Zopf, *B. ellenbachiensis*, Caron, *B. mycoides*, Fluegge, etc., are good examples of this class. These peptonized products (peptones and albumoses) are then converted into ammonia through the action of these same species and other ammonifying bacteria. The ammonia may then be converted into nitrate by another class of bacteria, principally *Nitromonas europae*, widely distributed in Europe, and by species of Nitrococcus, said to be peculiar to the soils of America and Australia.* The nitrate is then oxidized to nitrate by still another kind of bacterium, Nitrobacter.

On the other hand, if the soil is poorly aerated or deficient in moisture, lime, or other mineral plant foods, the course of this digestion or decay of organic matter is modified. Acids accumulate, and the bacterial action is largely replaced by that of fungi and forms of bacteria that can grow in the presence of acids. The organic matter becomes more or less pickled or humified. The more active forms of peptonizing and ammonifying bacteria and the nitrifying forms are suppressed by the conditions unfavourable to their development. Peaty soils represent the extreme of this type. In the improvement of such soils the great stores ot nitrogen and carbon of the humus may be made available by the addition of the mineral foods if they are lacking —especially carbonate of lime or potash—by proper aeration, and finally by the addition of the peptonizing, ammonifying and nitrifying bacteria. In the present state of our knowledge the last is best accomplished by spreading a few hundred pounds per acre of good, naturally rich, well-worked loam, which usually contains these bacteria. Care should be taken, however, to secure this inoculating soil from fields known to be free from serious weeds, insects, and plant-disease organisms. It is to be hoped that our knowledge of soil bacteriology will develop in the near future to the point where we will be able to determine by bacterial analysis what organisms are present in a given soil, and what bacteria are needed to raise the bacterial activity to the highest state of efficiency, assuming of course that the proper conditions for their growth have been supplied. Briefly, these conditions are a warm temperature, good aeration brought about by thorough and frequent cultivation, proper moisture conditions, also favoured by thorough and frequent cultivation, good drainage, and a good supply of decaying organic matter, carbonate of lime, phosphates, and other mineral foods.

The following table, taken from Bulletin 65 of the Delaware College Agricultural Experiment Station, by F. D. Chester, shows the varying activity of some of the bacteria here under discussion :—

*Hall, Alfred D., The Soil, p. 72, 1903.

Chemical functions of certain soil bacteria.

Species and culture.	I. Liquefaction and peptonization of media. Gelatin.	Blood-serum.	Milk.	II. Ammonifying coefficient.	III. Reduction of nitrates to nitrites.	IV. Acidifying coefficient. Dextrose broth.	Saccharose broth.
Bacillus tumescens, Zopf.							
Culture I. ...	+ +	+	+	1.2	–	1.66	1.85
Culture, 5139 ...	+ +	+	+	1.6	–	1.66	2.85
Culture, 5170 ...	+ +	+	+	2.3	–	2.57	3.60
Culture, 5198 ...	+ +	+	+	3.0	–	1.57	1.40
Culture, 5201 ...	+ +	+	+	4.2	–	——	——
Bacillus ellenbachiensis, Caron.							
Culture, I. ...	+ +	+	+	10.0	+	2.55	2.30
Culture, 5167 ...	+ +	+	+	25.0	+	2.44	3.00
Culture, 5200 ...	+ +	+	+	25.0	+	3.66	1.55
Bacillus alcaligenes, Petruschky, var. *pulvinatus*, Chester ...	–	–	–	Trace	+	0.	0.
Bacillus alcaligenes, var. *delavariensis*, Chester ...	–	–	–	13.0	–	0.	0.
Streptothrix soli, Chester	+	–	–	5.0	–	0.	0.
Streptothrix brown sp. indt. ...	–	–	–	5.0	–	0.	0.
Bacillus mycoides, Flügge.	+	+	+	12.0	+	2.22	2.71
Bacillus alcalescens, Ford.	–	–	–	2.3	+	1.80	1.80
Bacillus gracilis, Zim. (?)	+	–	–	10.0	–	0.	0.
Bacillus sp. indt.:							
Culture 5140 ...	+ +	+	+	10.0	–	1.77	1 30

In this table a single plus sign (+) indicates feeble or slow activity, a double plus (+ +) indicates a strong activity of the kind indicated at the head of the column, and a minus sign (–) indicates no activity of the kind. The figures in column II indicate the relative ammonifying activity, and those in column IV the acidifying activity. One important deduction from this table is that the different species vary widely in their ability to accomplish certain work and that cultures of the same species vary greatly. There is therefore opportunity to increase bacterial efficiency in a good soil by selection and introduction of the most effective species and the most effective strains of these species, and to reduce in number the inefficient and injurious species. The mere making of conditions favourable to a beneficial or desired species is not sufficient to insure its development unless there is a large number of individuals of the desired species present. There are many species of bacteria—good, bad, and indifferent—that can develop under the same conditions, just as there are many weeds that grow vigourously under conditions favourable to crops. It may be necessary in some cases to reduce the number of these forms. It is essential that an accurate knowledge be gained of *all* the organisms occurring in various soils, the changes that they produce, their symbiotic and antagonistic relations and the conditions affecting them, and the relation of their activity to crop production. Chester* has suggested a very good method for accomplishing this in a uniform manner. A few examples of some of his determinations of bacterial or zymotic efficiency of various soils will be instructive.

A soil from the experiment station garden, Newark, Del., consisting of a heavy clay loam which had been brought to a high state of fertility by ploughing under crimson clover for a number of years and kept under active tillage, gave the average results of two analyses as follows :—

	Per gram of dry soil.
Streptothrix soli	1,600,000
Bacillus tumescens	1,200,000
Bacillus alcaligenes var *delavariensis*	330,000
Total	3,130,000

As shown in the table on page 28, *B. tumescens* is the only one of these organisms that can convert nitrogenous matter into peptones with any degree of energy. The relative ammonifying power of these organisms is proportionate to the ammonifying power of the individual organism and to the number of organisms. On this basis this soil has a relative ammonifying efficiency of 13.73 and an acidifying efficiency of 2.22.

Nearly a year later (April 11, 1903) an examination of this same soil showed a great reduction in the number and activity of the bacteria present :

	Per gram of dry soil.
Streptothrix soli	20,000
Bacillus tumescens	745,000
Bacillus alcaligenes var *pulvinatus*	20,000
Bacillus ellenbachiensis	170,000
Bacillus mycoides	20,000
Streptothrix sp. indt.	319,000
Total	1,294,000

* Bul. 65, Del. Col. Agric. Exp. Sta.

The relative ammonifying efficiency of the soil at this time was determined to be only 2.48 and the total acidifying efficiency 1.81. The bacterial or zymotic efficiency of this soil is therefore much lower than it was at the first examination.

On May 11, 1903, a sample of soil from sandy land which had been brought into a good state of fertility was examined, with the following results:

	Per gram of dry soil.
Bacillus ellenbachiensis	140,000
Bacillus alcaligenes var *delavariensis*	380,000
Bacillus tumescens	20,000
Total	540,000

The relative ammonifying deficiency is 8.9; the acidifying efficiency only 0.58. It is interesting to note that the bacterial efficiency of this soil is nearly three times as great as that of the station soil at the second examination, though the latter contained approximately three times the number of bacteria. This is explained by the great efficiency of *Bacillus ellenbachiensis*.

Nitrification and nitrogen-fixing activity can be determined and expressed on a relative basis in a similar manner. The addition of available nitrogen to soils through the decay of nitrogenous matter can never exceed or even approximate the amount taken from the soil in the production of that organic material. It represents a gain in nitrogen only in the sense that it is saved. It is not desirable that its conversion into soluble form should much exceed the demand of the crop; otherwise it may be lost. It is evident, however, that with the great waste of organic matter which must inevitably go on we must have other sources of nitrogen to cover the loss and meet the rapidly increasing demand for it, not only in agriculture but in other arts.

THE FIXATION OF ATMOSPHERIC NITROGEN BY SOIL BACTERIA.

Leaving, now, the question of the changes in the nitrogenous organic matter in the soil, we will consider the fixation of atmospheric nitrogen by a class of bacteria that uses the carbohydrate constituents (sugar, starches, cellulose, &c.) of the vegetable matter in the soil. There are two classes of bacteria that can fix atmospheric nitrogen: (1) Those that are not associated with any particular crops, and (2) the root-nodule forms associated principally with legumes. The first group depends on the carbohydrate material in the organic matter of the soil derived from decaying vegetation or from certain minute algae (the Cyanophyceae or blue-green algae). The second group depends principally on the carbohydrates supplied by the plants in the roots of which the bacteria are growing. The latter class will be considered later.

The independent soil forms are widely distributed and belong to several genera. A very good comparison of some of these has been made by Chester, and is shown in the table below taken from Bulletin 66, Delaware College Agricultural Experiment Station.

Gains of nitrogen in nitrogen-poor media by certain nitrogen-assimilating organisms.

Species of organism in culture.	Duration of culture in days.	Milligrams of nitrogen per 100 c.c. of uninocculated medium (plank.)	Milligrams of nitrogen per 100 c.c. in culture.	Grains of nitrogen in culture in milligrams per 100 c.c.	Percentage of gain of nitrogen.*
Alfalfa root-tubercle organism pure culture ...	14	0 600	1.200	0.600	100
Do. ...	40	.532	2.002	1.470	276
Do. ...	15	.490	1.484	.994	203
Do. ...	30	.578	2.450	1.872	324
Bacillus tumescens ...	16	.446	1.490	1.044	234
Do. ...	28	.446	1.600	1.154	259
Pseudomonas fluorescens var. *nonliquefaciens* ...	16	.400	1.710	1.310	327
Do. ...	8	.400	1.720	1.320	330
Bacillus candicans ...	15	.490	1.372	.882	180
Do. ...	30	.578	1.542	.964	167
Do. ...	28	1.00	2.12	1.12	112
Bacillus alcaligenes ...	15	.490	1.172	.682	139
Do. ...	30	.578	2.940	2.362	401
Do. ...	28	1.00	1.87	.87	87
Bacillus ruminatus ...	28	1.00	1.81	.81	81
Bacillus fluorescens ...	28	1.00	1.87	.87	87
Bacillus aurantiacus ...	28	1.00	2.25	1.25	125
Azotobacter with—					
Bacillus aurantiacus ...	15	.490	1.642	1.162	235
Bacillus salmoneus ...	30	.578	1.890	1.312	227
Azotobacter with—					
Bacillus candicans ...	15	.490	1.792	1.302	266
Bacillus aurantiacus ...	30	.578	2.556	1.978	342

In warm, well-aerated soils containing sugars, starches, and cellulose from decaying grasses and other vegetation, and well supplied with carbonate of lime or other bases and mineral foods, these bacteria fix considerable atmospheric nitrogen. The amount of course, depends upon the nature and amount of carbo-

* The figures in this column are about 100 less than those given in the bulletin ed and show the actual per cent. of gain in nitrogen.

hydrate food available, the species present, their number, and the degree of favourableness of the other factors mentioned. In ordinary cultivated soils the supply of available carbohydrate materials is the factor that usually limits free-nitrogen fixation. The almost complete removal of crops leaves very little carbonaceous food for these bacteria. To stimulate the development of these bacteria, assuming that they are present, it is essential that considerable carbonaceous matter be incorporated into the soil.

In grass lands and in wild lands generally, where much of the carbonaceous matter produced finally becomes incorporated with the soil, the fixation of atmospheric nitrogen by the Azotobacter group* and the other independent nitrogen-fixing bacteria is very great. An examination of two fields at Rothamsted which had run wild for more than twenty years showed an accumulation of nitrogen of approximately 45 pounds per acre per annum in a field poorly supplied with carbonate of lime, and 98 pounds per acre per annum in a field well supplied with carbonate of lime. Bacteriological tests of these fields showed that Azotobacter was present in much larger numbers and had greater powers of fixation in the field containing an abundance of carbonate of lime.†

This has been going on in connection with, but entirely independent of, nitrification for ages, wherever the conditions are favourable and the proper bacteria are present. This is true especially of prairie soils in all parts of the world. The work of these organisms represents an absolute gain in available nitrogen. It is highly essential that we should learn more about them and get better control of their activities for the benefit of agriculture. An attempt has been made to do this in the preparation of "Alinit," which is a culture of *Bacillus ellenbachiensis.* This is, however, a species of very small, if any, nitrogen-fixing power. It is of more value as a peptonizer and ammonifier. When it has given good results it has probably been where it was needed for such work rather than nitrogen fixation. Success in the use of cultures can come only when bacteria of high efficiency are selected for a particular kind of work, and are used under conditions favourable to their development and where examination indicates that they are needed. A few failures due to imperfect knowledge must not discourage workers in this important field. Excellent work is being accomplished in the study of these forms in this country, especially by Voorhees and Lipman, of the New Jersey station, and Chester, of the Delaware station.‡

ROOT-NODULE BACTERIA.

The bacteria of this class, like the Azotobacter group, are able

* Beijerinck, who described these forms, holds that Azotobacter can fix atmospheric nitrogen only in association with other forms, such as Granulobacter and Radiobacter. This point, however, is not yet definitely settled. It is settled, though, that these forms working together fix nitrogen much more actively than when they work independently.

† Science, new series, Vol. XXII, p. 455.

‡ See Bul. 180. N.J. Agr. Exp. Sta., and the station reports for 1903 and 1904; also the Delaware station bulletins previously referred to.

under favourable conditions to fix more or less atmospheric nitrogen independent of legumes. They reach their highest efficiency, however, when growing in the roots of legumes (clovers, alfalfa, peas, beans, &c.,) where they usually form nodules. The origin of the species is possibly from a solid form, Radiobacter, commonly growing in association with Azotobacter.

The value of leguminous crops as soil improvers has been well known for centuries, and they are regularly used for this purpose, especially in the older agricultural countries. It is, however, only since the work of Hellriegel and Wilfarth in 1888 that it has been universally recognized that the ability of these crops to grow in soil devoid of nitrogen is due to the presence of certain bacteria in the root nodules. These bacteria have been carefully studied by many investigators in Europe and in this country, and much valuable information has been secured regarding them. The literature of the subject has been reviewed so many times in various publications that it is not necessary to go over it again.*

It has been amply demonstrated, not only by hundreds of years of actual experience, but by numberless carefully conducted experiments in many countries, under widely varying conditions, that clovers and numerous other legumes supplied with tubercle bacteria obtain from the air through the agençy of these bacteria under favourable conditions, all the nitrogen they require, and that they leave in the soil considerable quantities for succeeding crops. In Germany the amount of nitrogen added to the soil by legumes, besides that taken off in the crop, is estimated at 200 pounds per acre. In the United States the average for sixteen States is 122 pounds, equivalent to not less than 800 to 1,000 pounds of nitrate of soda per acre.* These effects, of course, are secured where the conditions for fixation are favourable, viz., where the soil is abundantly supplied with nodule bacteria of high efficiency and where the available nitrogen content of the soil is low and the soil is well supplied with carbonate of lime or its equivalent, and when the phosphates and other elements of available plant food are present in sufficient quantity. If the soil is already rich in nitrates, the leguminous crop may do no more than maintain the nitrogen equilibrium. This is an important thing to do, however, inasmuch as this nitrogen will be required by subsequent crops in the rotation and the requirement of expensive nitrogenous manures is thereby reduced.

VARIETIES AND EFFICIENCY OF ROOT-NODULE BACTERIA.

It is now pretty well agreed that the nodule bacteria on most legumes belong to the same species. However, there are well-defined strains or varieties especially adapted to certain genera and species of legumes which adapt themselves with more or less difficulty to other genera and species. The immediate efficiency of the bacteria will, therefore, depend upon the natural or artificial inoculation of the particular legume with the best strain of bacteria adapted to it. In soils, therefore, where it is desired to cul-

* See Bulletin 71 Bureau of Plant Industry.

tivate a particular legume, and where that legume or a closely related species has not been successfully cultivated and well supplied with nodules, it is desirable that the proper bacteria be supplied. Experiments and practical tests made by this Department show that there is a great variation in the nitrogen-fixing power of these bacteria, dependent in part upon the conditions under which they have been growing. If they are in a soil which provides them with an abundant supply of combined nitrogen they ultimately lose, to a large extent, the power of fixing atmospheric nitrogen. Under such conditions they are of little or no benefit to the crop. It is an easy matter to select strains of high nitrogen-fixing power as indicated by the effect of the bacteria on the crop when growing in comparatively nitrogen-free soils. The cultivation of these selected strains on nitrogen-free media for a few generations greatly increases their nitrogen-fixing power, and therefore their value for inoçulation purposes. Exactly the same principles apply to these bacteria as apply to other plants. There are some strains of beets that will make 15 to 20 per cent. of sugar. These are worth cultivating for their sugar: but the ordinary strains from which these have been developed by selection contained only 5 or 6 per cent. of sugar. A man who wants to make a success of growing sugar beets plants seeds of high sugar-producing strains. The importance of using selected seed for all crops has been so amply demonstrated that no argument in favour of the practice is needed. It is the very foundation of progress in plant culture. Soil bacteria are no exceptions to the rule, and pure-bred bacteria for specific work are as clearly an economic necessity as pure-bred cattle or pure-bred sugar beets.

DISTRIBUTION OF INOCULATED SOIL.

We are often told that these bacteria are widely distributed and are present in most soils. This is true as applied to the older cultivated areas, where various legumes have been cultivated, but it does not follow that soils containing a few or even a considerable number of these bacteria would not be benefited by inoculation with suitable kinds of bacteria. The varieties present may not be adapted to the legume which it is desired to plant, and may have little or no beneficial effect on it, or if the proper strain is present in small numbers it may, and usually does, take several years to bring the bacterial content of the soil up to an efficient basis. This, of course, is too slow a process. It would be just as reasonable to depend on getting a crop of clover or blue-grass in this way. It can be done in some places, but it is at least a makeshift method and does not appeal to a practical up-to-date farmer.

In newer regions, where legumes have not been cultivated, very few soils have enough of these bacteria in them to be of any practical value, and inoculation is essential. This may be accomplished either by the use of soil from a field where the crop is making a vigorous growth by the roots well supplied with nodules, indicating that the soil contains the right bacteria, or by the use of pure cultures from selected plants. The soil method, of course, introduces not only the nodule-forming species, but numerous other forms, snch as those previously discussed in this paper, and these may often be as much needed as the tubercle forms. Where they as well as the nodule forms are needed, soil transfer is usually the most satisfactory method of inoculation. This is likely to be the case in "sour" soils. It is, however, expensive and cumbersome, especially where the soil has to be transported for some distance.

Another and much more serious drawback to this method is the danger of introducing into a farm injurious and disease-producing bacteria and fungi, as well as troublesome weeds. It is not safe to use soils from areas in which such pests occur. Anyone who has seen the great injury wrought by root nematodes, the wilt diseases of melons, cowpeas, tobacco, cotton, tomatoes, potatoes, flax, the black-rot of cabbage and cauliflower, the various stem and root diseases of clover and alfalfa, and diseases of other crops almost too numerous to mention, and widely distributed, will investigate carefully before importing soil that may contain the spores of these organisms.

PURE-CULTURE INOCULATION.

For the reason above mentioned, pure culture inoculation must eventually mainly replace the soil-transfer methods for all kinds of soil inoculation, but this has not yet been put on a practical basis for any except the nodule bacteria. The improved cultural and selection methods introduced by this Department in the practical handling of these forms have brought within reach of every farmer who may need them pure cultures of the most virile, vigorous, and best types of root-nodule bacteria for each particular leguminous crop. It requires care and skill, however, to make and keep these cultures in good condition. For lack of this many who have tried to make these cultures have failed. The pure culture method has come to stay, however. It will be improved by experience aad continue to increase in usefulness in the hands of careful and progressive workers. It is suggested, before using cultures from any source, that farmers secure from this Department and read carefully Farmers' Bulletin 240. The Department of Agriculture is distributing the bacteria during the present season (1906) in nitrogen-free liquid cultures hermetically sealed. Excellent results can also be obtained in distributing the cultures in dry form. They must be dried quickly, however, from solutions containing very small amounts of soluble salts, and kept dry until ready for use; otherwise they are likely to mould and spoil. This Department has used this method very successfully for several years. It is also used successfully by Ferguson, of the Virginia Experiment Station.*

THE FIXATION OF NITROGEN FROM THE ATMOSPHERE BY ELECTRICAL METHODS.

While much can be accomplished through the agency of soil

*See Bul. 159, Virginia Agr. Exp. Sta.

bacteria in conserving and increasing the supply of combined nitrogen there will always be a demand, in intensive culture especially, for an immediately available supply of nitrates or other forms of fixed nitrogen. The great Chilean deposits, which furnished more than one and a half million tons in 1905, will, at the present rate of use, according to careful estimates, be exhausted in less than fifty years. It has long been known, however, that atmospheric nitrogen can be oxidized under the influence of electricity, producing nitric oxid fumes, which are then combined with water, to form nitric acid, or with quicklime, forming calcium nitrate. Other bases may also be used. Various attempts have been made from time to time to develop a process by which nitrogen can be combined commercially. The most promising results have thus far been secured with Franck's process of making calcium cyanamid and with the Birkland and Eyde process of producing nitra. The former process consists in combining nitrogen with the carbides of alkalis, producing cyanids, or, in the case of calcium, producing calcium cyanamid ($CaCN_2$), containing 35 percent of nitrogen more than twice the amount present in Chile saltpeter. The calcium cyanamid, when properly used, has proved to be an excellent nitrogeneous fertilizer for many crops, and quite equal to ammonia compounds, into which it can be readily converted. The ammonia thus produced, can be further oxidized by conducting it over highly heated metallic oxids, thus producing nitric acids.

The Birkland and Eyde process, however, appears to be the most promising as a means of producing nitrates. A special electric furnace is used, in which an alternating electric arc between 3,000 and 4,000 volts is produced in connection with a large electro magnet, which forces it to take the form of a roaring disk of flame. Air is forced through this furnace at the rate of about 3,000 cubic feet per minute, the nitrogen being oxidized in the furnace to nitric oxid. These fumes are then collected, and after further oxidization are absorbed in water towers, forming nitric acid, or by powdered quicklime, forming calcium nitrate. Of course the nitric acid can be combined with almost any desirable base, such as soda or potash. With cheap water power nitrates can be produced by this process to compete in cost with nitrate of soda.*

These direct processes of securing nitrogen will be rapidly improved, and what has been accomplished already in this direction should remove the last vestige of doubt that we shall be able to secure at a reasonable cost all of the immediately available nitrogen we may need, in addition to the great supply that may be secured through bacterial action.

* See "Nature", vol. 75, p, 355; also, Exp. Sta. Record, vol. XVII, pp. 746-750. For a full illustrated account see Engineering News, vol. 57, No. 6. pp. 150, 151.

CEARA OR MANICOBA RUBBER, II.*

MANNER OF COLLECTING THE RUBBER.

Having finished the operations just explained in the opening of the hole, and the fixing of the receivers, &c., the work consists of simply filling the receivers with pure water or with the solution which you had to employ. Continuing thus, making the cuts quickly, substituting the water or solution when necessary, every morning or as early as possible, whilst the temperature is still low, make the "taps" as explained working several at the same time, continue this work up till 9 or 10 a.m. on hot days.

In the afternoon it is customary to continue the collection by new "taps;" it is found more convenient, only in the morning, leaving the collection of the rubber, after several "taps" every two days, according to the process which has been adopted.

After the "tap" is made, after a short delay the milk runs and after a while coagulates and closes the cut; this time is more or less prolonged, according to the different causes, such as, temperature, repressing of the milk, &c. Should it be necessary, clean off the coagulated rubber from the cut so as to have a fresh discharge of milk.

After some amount has accumulated in the basin it should be collected, then tap again and place new water or solution in the basins. This rubber is taken to the house still wet and placed in the press, according to the process for moulding and uniting the different fragments, and thus enabling the rubber to be delivered to the market in a neat manner,—slabs of 1 centimetre thick are best so as to avoid fraud.

USE OF THE PRESS IN THE PREPARATION OF THE RUBBER FOR DELIVERING TO THE MARKET.

Owing to the rapid coagulation of the milk and to the slight sweating, fractionizing the collection, the use of presses cannot be dispensed with so as to unite the fragments in a body more voluminous and endowed with advantageous conditions. By any of the processes employed, the rubber obtained is taken to the press still wet and fresh because in this state it is easier to unite under the compression of the press.

Any system of press may be employed, so long as its compressing powers are sufficient so that it can unite the fragments in one solid body. Cylinders of iron covered with wood may also be employed, or even of wood with a gradation in order to compress the rubber to the thickness required.

USE OF SMALL CUPS OR BASINS: HOW THEY SHOULD BE MADE AND WHICH ARE PROFITABLE.

It is impossible to dispense with the small cups. When a superior product is required these small cups have to be made according to the process which practice proves to be the best to be adopted.

* Translated from Bolitim: See de Agricultura, &c., Bahia, II, 2., Aug., 1903. We are indebted for the translation to Mr. D. A. Wetherall. *Editor.*

If adopting the alum the caps cannot be made of iron, nor of any metal attached thereby, neither can "tapping" be done with a steel instrument, because it blackens the product.

Also the form and material in which they have to be manufactured differ, when they are destined for use on the branches they must be made of light material if they are for the roots then they may be made of heavy stuff.

According to the above, we must use for the extraction of the milk from the roots, cups of raw clay, which although they improve the product, still are liable to crack and allow part of the milk to escape, and deposit itself in the soil.

For the use of extraction by the roots, the best cups or basins should be those of clay baked and glazed inside, which stops the filtering through of the water or solution employed. They should affect the form of a semi-circumference, ten centimetres in diameter [4 inches] offering the greatest surface at the part which has to remain adherent to the root to permit of several cuts being made. To where the cups or basins adhere perfectly to the root it is necessary at the point of junction, to place clay plaster to fasten the cups to that part.

The cups can be made of zinc sheet. A cow's horn can also be used. The cups for the extraction from the branches should be as deep as a glass.

We will now treat of a part no less important,—knowing the mean production from a tree in a wild state, and advantages of culture of Manicoba.

MEAN PRODUCTION OF RUBBER PER TREE.

Collecting carefully and separately the production obtained from fourteen trees, was found to give the mean of 57·73 grains per plant.

Afterwards taking another production of ten trees the mean was 77·15 grains, per plant.

We found one tree whose production taken by itself attained 197·50 grains.

According to these results obtained under the irregular conditions of the dry and bad season, it is seen that the mean is not disappointing, it should also be noticed that those trees submitted for the test, in the majority had already suffered from previous tappings.

PRODUCTION OF A TREE IN ITS WILD STATE UNDER NORMAL CONDITIONS.

Taking into consideration the dry and bad seasons and the losses in the extraction, it may be safely estimated at 100 grains the mean of production of one tree in its wild state, during the time it is undergoing tapping.

* * * * * *

THE MANICOBA AS PRODUCER OF FORAGE.

The seeds constitute a food, liked by cattle, and of great alimentary power from the richness of fat materials, and can be ground to produce a rich forage, superior perhaps to the flour of the seeds of cotton and other similar seeds.

THE TIME WHICH PASSES FROM CULTURE TO PERFECTION.

It appears to us that the Manicoba has a rapid growth, principally at the commencement of the development, we believe that from the 4th to 5th year it can produce, but the maximum of production is during the 8th year forward, as with the cocoa and other plants.

* * * * * *

AUGMENTATION OF THE PRODUCTION OF RUBBER IN MANICOBA DURING THE EXTRACTION OF THE MILK.

Manicoba is educated in its production of rubber or of milk, in the same manner as the breasts of animals are habituated to give the maximum production of milk ; during our labours we observed the augmenting in the production of milk, after repeated taps, the fact is known to all the extractors of rubber from Manicoba.

CITRATE OF LIME AND CONCENTRATED LIMEJUICE.*

BY THE HON. FRANCIS WATTS, C.M.G., D.Sc., F.I.C., F.C.S.,

Government Analytical Chemist and Superintendent of Agriculture for the Leeward Islands.

Interest in citrate of lime has recently increased in the West Indies from the fact that the article is now being made and shipped on a fairly large commercial scale from the Islands of Dominica and Montserrat. In previous papers,† I have discussed the details of its manufacture and have little to add to what has been already said except, perhaps, that it might be found that a well-prepared juice, free from pulp and charred matter, might find direct application in some of the arts, and thereby command a higher price.

One somewhat important point has however been brought to my notice by one of the West Indian makers of citrate, namely, that hot lime-juice filters readily through suitable cloth. This fact admits of application in the manufacturing process. In making citrate it is desirable first to heat the juice in a still so as to recover the essential oil, which is a valuable commodity ; after distillation the hot juice can be run through filters, which may

*West Indian Bulletin, VIII., pp. 167–172.

†*West Indian Bulletin*, Vol. II., p. 308, and Vol. III., p. 152. Also in *Bulletin of the Botanical Department, Jamaica*, Vol. V., 1898, p. 263; Vol. IX., 1902, p. 187.

advantageously be made on the lines of the well known Taylor-bag filters commonly used in sugar manufacture. The clear filtered juice is then used for the preparation of citrate in the manner previously described.

Another useful suggestion, for which I am indebted to the same gentleman, is that the juice can be readily and economically heated by blowing naked steam into it, and that, by using a suitably perforated pipe, the steam so agitates the juice as to obviate the use of a mechanical stirrer. It is preferable to let the steam into the juice on one side of the mixing vat so as to cause a regular circulation. If the juice is brought into the mixing vat as soon as possible after leaving the still, so as to retain a good deal of heat, the dilution caused by the naked steam is reduced, and therefore the filters should be arranged to retain the heat as much as possible. Mixing vats of wood answer the purpose admirably,

The best forms of drier appear to be those in which warm air is drawn over the citrate deposited on shelves; these driers are of the type of cacao driers described in the *West Indian Bulletin*, Vol. II., p. 173.*

As regards the relative advantages of making citrate or concentrated juice, I have nothing to add to what I said in the *Wes Indian Bulletin*, Vol. III., p. 152. The question appears to me to be still an undecided one.

In order that those interested in the subject may form some idea of the appliances required for the manufacture of citrate, I append here plan for a citrate factory capable of dealing with a crop of about 12,000 barrels of limes, equivalent to a crop of about 100 casks of concentrated juice.

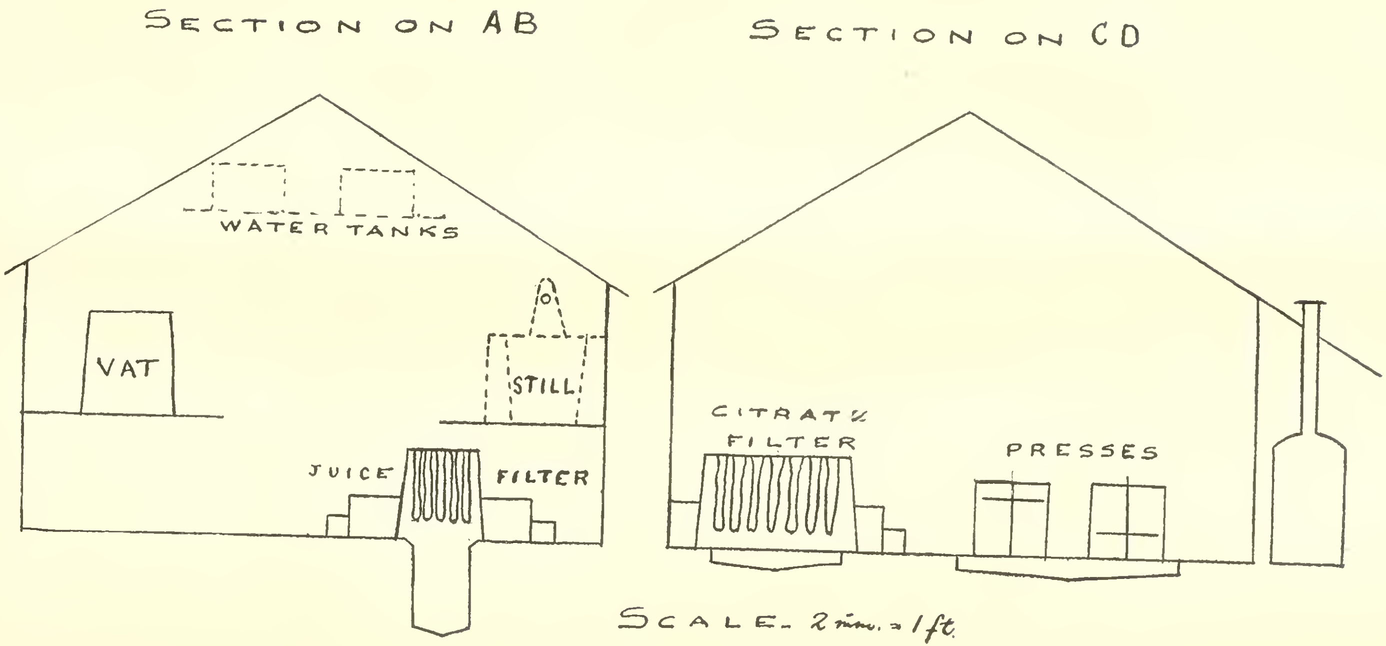
Considerable improvements may be effected in the manufucture of concentrated juice. In the first place, the juice should be freed from pulp and suspended impurities before concentrating. This is now found to be a comparatively simple matter. It is usual to heat the juice in a still in order to recover the essential oil. When the distillation is finished and the hot juice discharged from the still, it is readily clarified either by allowing it to stand in vats to permit the suspended impurities to subside, or preferably, it may be passed through bag filters in the manner mentioned above.

Concentrated juice prepared from clarified lime juice is comparatively free from suspended impurities, and is a superior article to much of the concentrated juice now commonly placed on the market. Some suspended impurities are present, however, these result from the action of heat on the juice in the process of concentrating.

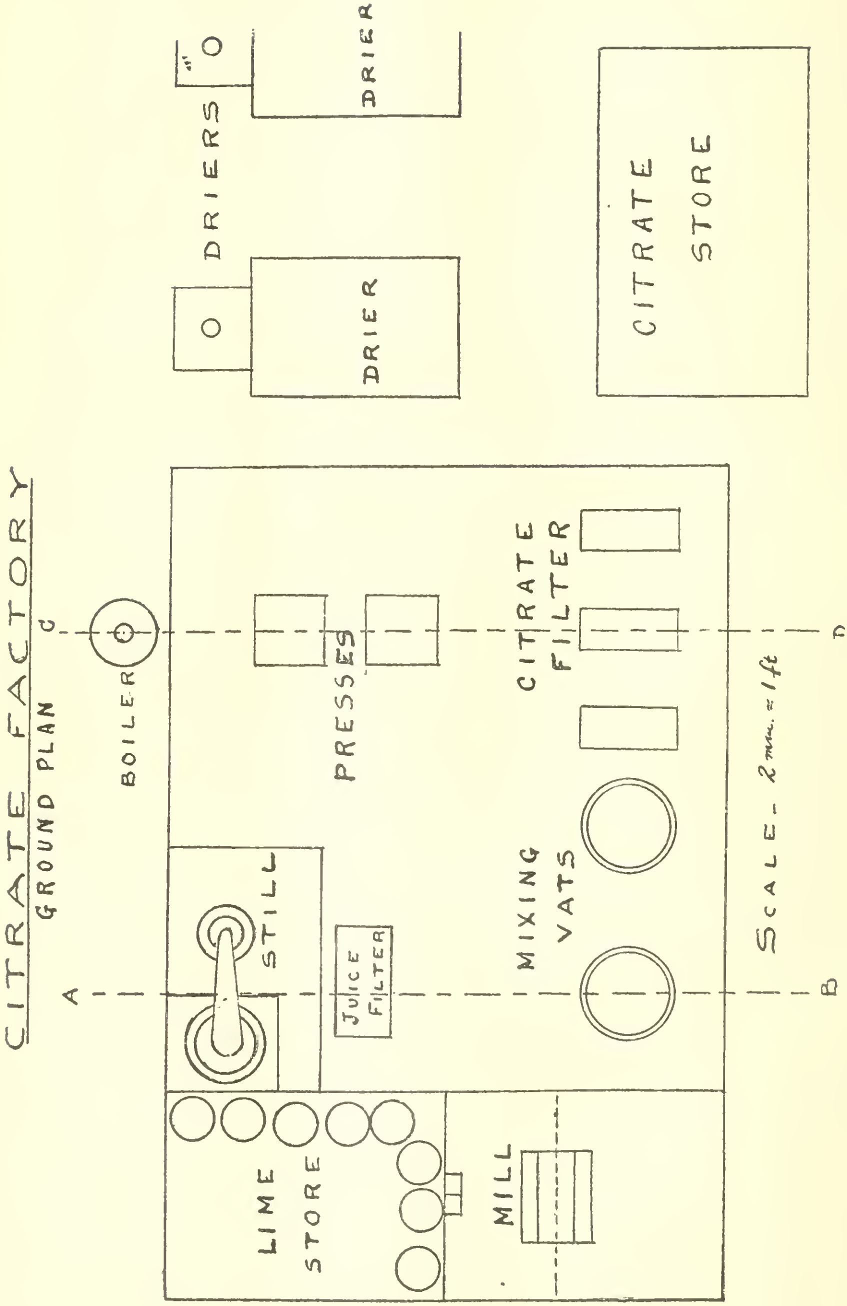
It is important that the concentration should be controlled by means of the citrometer in the manner described in the *West In-*

*Driers of this kind are made by the Blackman Export Co., Ltd., 70 Finsbury Pavement, London, E.C.

CITRATE FACTORY



SCALE. 2 mm. = 1 ft.


CITRATE FACTORY
GROUND PLAN
A
B
C
D
BOILER
STILL
JUICE FILTER
PRESSES
MIXING VATS
CITRATE FILTER
LIME STORE
MILL
DRIERS
DRIER
DRIER
CITRATE STORE
SCALE - 2mm. = 1ft

dian Bulletin, Vol. II., p. 309, which briefly is this: 'Carry on the concentration until the citrometer, when immersed in the juice at the boiling temperature shows a density of 66°.'*

A much finer product would be obtained if the juice were concentrated in steam-heated pans instead of over open fires. It is suggested that shallow wooden vats heated by steam coils of copper or block tin will serve for this purpose. I have not seen such appliances in use, but the suggestion is one well worthy of consideration and should commend itself to planters for trial.

I am informed that there is a demand for the better qualities of concentrated lime juice for direct use in various arts and manufactures in the place of crystallised citric acid. This is of importance, for, if a fine quality of concentrated juice, of good colour, and free from suspended impurities can be placed on the market, it is reasonable to suppose it will be in demand for those purposes in which a solution of citric acid can be employed in place of the crystallised acid, and should command a higher price than ordinary concentrated juice.

ADDENDUM.

THE USE OF CENTRIFUGALS FOR DRYING CITRATE.

Until recently I was of opinion that it was sufficient to press the wet citrate in bags in order to remove the superfluous water before putting the citrate in the drier. I have, however, recently had an opportunity of conducting some experiments with citrate, as produced on a commercial scale, and have ascertained that a centrifugal will remove a considerable quantity of water from citrate which has already been well pressed.

The experiments were conducted with a model centrifugal having a basket 5 inches in diameter and run at a speed of about 3,000 to 3,500 revolutions a minute; thus developing a centrifugal force of about the same intensity as that obtained in large centrifugals in commercial use.

The experiments also demonstrated very clearly that citrate can be handled very conveniently by means of centrifugals. The centrifugal employed for the experiments was lined with twill cloth, of the kind used for press cloth. There was no tendency for the citrate to force its way through the cloth and the water was removed with striking rapidity. The centrifugal removed a considerable quantity of water from citrate which had already been well pressed.

The citrate may be washed very conveniently in the shortest space of time and with the minimum amount of hot water while it is still in the centrifugal, thus producing a pure citrate of good colour.

It has frequently been noticed that citrate dries with difficulty when it has been so handled as to produce a plastered surface on

* Citrometers may be obtained from Messrs. Baird and Tatlock, 14 Cross Street, Hatton Gardens, London, W.C., Messrs J. Long & Co., Eastcheap, London, E.C. or from most dealers in chemical apparatus.

the lumps. The press has a little tendency in this direction, but careless handling may accentuate this condition. Citrate which comes from the centrifugal is in a dry pulverulent state in which it dries rapidly, and the resultant dried citrate is freed from lumps, and is softer and more friable than that which had been pressed.

The advantages to be gained by the use of the centrifugal may be summed up as follows :—

a. Convenient and rapid handling.
b. Rapid and thorough removal of water.
c. Convenient washing.
d. More rapid drying in drier, and consequent saving of time and fuel.
e. Better condition of finished citrate.

Where citrate of lime is made on a large scale I have no doubt that the use of the centrifugal instead of the press is to be recommended, for it should be found very materially to improve the conditions of working.

CITRATE OF LIME.

Mr. JOSEPH JONES, Curator of the Botanic Station, Dominica, has submitted the following note on citrate of lime in Dominica :—

The manufacture of citrate of lime in Dominica was taken up a short time ago by one firm, and the results of these initial experiments have proved very satisfactory. The citrate was favourably reported on in London, and the analysis showed 69 per cent of citric acid.

The quantity of citrate of lime exported from Dominica to December 30, 1906, was 728 cwt., valued at £1,555, and so successful have been these early efforts that very considerable development along these lines may be expected in the near future.

At present the bulk of the lime juice produced in Dominica is concentrated for export. Under this system there is a great loss of acid. If citrate of lime is carefully made there should be a very small loss of citric acid, and although it is more expensive to manufacture, it is a superior product and commands a higher price than concentrated juice.*

It is probable that along the Leeward side of Dominica where transport by water is but rarely interrupted by bad weather, a factory or factories for making citrate may be erected, and the raw juice purchased from the estates and small growers. Pro-

*It is calculated that in making concentrated juice the loss of acid may be about 6 to 16 per cent. under conditions of careful working, whereas in making citrate it may perhaps be put down at about 3 per cent. Making citrate requires more care and skill than is necessary for the manufacture of concentrated juice, and the cost of the chalk has to be added to the cost of working. There is probably little or no saving in fuel in making citrate, no saving of freight, and possibly little saving in packages. [Ed. *W. I. B.*]

vided the planter has an interest in the factory such a development is to be looked for.

The preparation of lime juice would then be separated from estate's work, and the planter would have more time to attend to the culture and manurial requirements of his lime trees.

The highest commendation is due to those planters who by making citrate, or by preparing a very pure concentrated juice, are seeking to raise the quality and the value of the products of the lime industry in Dominica.

LIME JUICE CONCENTRATION.

The following brief note on lime juice concentration has been prepared by the Hon. J. C. MACINTYRE, of Dominica, and should prove of interest:—

The need for improving the quality of West Indian concentrated lime juice has long been apparent, and during the last few years attention has persistently been directed to this fact by Dr. Watts, merchants, and others interested in the sale of the product.

It has been pointed out that the great difference between the price of Sicilian and West Indian juice, amounting usually to about £3 per hhd.,* is very largely due to the indifferent preparation of the latter, for it usually contains large quantities of pulp and foreign matter, and carbonized juice due to excessive concentration.

Efforts at improvement have usually taken the direction of attempts to clear the raw juice and have invariably resulted in failure for the following reasons:—

(1) Raw juice takes long to settle, and therefore very large storage capacity is necessary. This alone would render the adoption of this method impossible on most estates.

(2) Subsidence is never complete, it being only possible to draw off as clear juice 60-65 per cent. of the entire quantity, and the residue, a thick mass of pulp and oil, defies every effort at economical treatment.

It was not until attention was directed to clearing the juice after distillation that any substantial improvement was effected. The process of distillation removes the oil, and if the juice is then run into subsiding vats, the pulp as well as a good deal of the gummy matter contained in the juice, rapidly settles to the bottom along with the heavier impurities. The supernatent liquid can, after the lapse of a few hours, be drawn off perfectly clear, and the remaining juice recovered from the sludge, with which it is mixed, by the use of 'brewers' filters.

These filters are merely canvas bags enclosed in one outer casing of loosely woven twine. They are cheap, simple, and quite efficient.

*Market quotations are made as for a pipe of 108 gallons, of 64 oz. of citric acid per gallon. West Indian concentrated lime juice is shipped in packages of half this size, but inasmuch as the juice contains usually about twice the quantity of acid, it is customary to regard the quotation as referring to a hogshead of West Indian juice, and it has been so treated here.

Clearing juice in this way adds practically nothing to the cost of manufacture if the works are suitably arranged. In my works the juice is pumped from the mill into vats placed high up in the boiling house, thence it pours into the still and from that into the subsiding vats. These are fitted with taps 8 inches above the bottom for drawing off the clear juice, and a plug hole in the bottom for removal of the sludge. After subsidence, the clear juice is run into the tayche and the sludge thrown up into filter tanks, from which the filtered juice finds its way also to the tayches.

During the first season my entire crop was treated in this way ; and that the results were satisfactory may be judged from the remarks of Messrs. Ogston and Moore, analytical chemists of London, who, reporting on sample drawn from a large shipment of juice, said : 'we do not think concentrated lime juice can be better made.'

As to the resulting increase in the market value of the product, I am not yet in a position to speak from personal knowledge, as all my juice has been supplied to contract at a fixed price. Messrs. Scrutton, Sons & Co., however, replying to a query on the subject, wrote : 'There can be no doubt that it pays to be careful with your concentration. Of this fact we have had proof during the past season, as we have been able to obtain 30s. per hhd. more for juice which was thin and clear, and which contained less than 115 oz. of citric acid per gallon.'

Dr. Watts has repeatedly drawn the attention of planters to the great loss of acid resulting from excessive concentration, and the above quotation further emphasizes the advantage of boiling to only a moderate density.

I may remark that an increase in price of 30s. is equal to a net gain of over 28s. after deducting discount and charges, based on the value of the product.

HISTORICAL NOTES ON ECONOMIC PLANTS IN JAMAICA.—VII.

TOBACCO.*

By the Editor.

The history of economic plants in Jamaica is part of the history of the efforts made by the British Government to aid the colonies. The wide knowledge, wise counsels, and great wealth of Sir Joseph Banks were always at the service of the Government for the purpose. In later years, when the Royal Gardens at Kew were presented to the nation, and the establishment there gradually grew in value and influence under the fostering care of the Hookers, father and son, and later still of Thiselton-Dyer, the efforts of the Government became systematic and continuous, and conse-

*A paper prepared for the West Indian Agricultural Conference, 1907. Reprinted for the *West Indian Bulletin*, Vol. VIII., 1907, page 209.

quently still more valuable to the colonies, especially to such colonies as maintained Botanic Gardens which were in constant communication with Kew.

The history of the tobacco industry in Jamaica is a good illustration.

Sir Joseph D. Hooker has been good enough to state in a letter to me written in October, 1905, what he did to assist it, as follows :—

'When Sir J. P. Grant was appointed Governor,* he, being an Iudian friend of mine, asked me what he could do for the introduction into the island of useful vegetable products, and he came and stayed with me for a couple of nights, to talk it over. I reminded him that it was a scandal that with the East and West Indies in our possession we had not a good cigar from either, and that in India† nothing but Manilla cheroots were smoked by Europeans, and in England Havanas. I suggested my getting seeds, together with histories of their manufactures, of various kinds from Cuba, Manilla, etc., through our Consuls, and that he should get some enlightened Jamaica proprietors to commence the cultivation. This we carried out, and in the third year Sir J. P. Grant sent me a sample of tobacco grown in Jamaica from these seeds, which I sent to an expert in London who pronounced it most promising. I also suggested to Sir John offering prizes for the best cigars.

'My old friend Musgrave† sent me several boxes of excellent cigars. Afterwards, the quality of the article went down, some boxes I ordered arrived full of weevils and were carelessly packed, and I gave up smoking the Jamaicas. Quite lately I have had good accounts, and the box you sent bears testimony to them.'

Mr. Robert Thomson, Superintendent of Public Gardens, in his Annual Report for 1868-9, acknowledges the receipt from Kew of packets of tobacco seed of Manilla, Havana, and Latakia. A plot was grown at Castleton of Latakia on account of its free-growing and vigorous habit and a sample of it forwarded, through the kindness of Dr. (now Sir) J. D. Hooker, to a London authority on the subject, who reports favourably of it, and says after suggesting some improvements, etc., as to preparing it for market, that 'the general appearance of the leaf is such that its cultivation should be encouraged In Jamaica.'

In the *Jamaica Gazette* for July 8, 1869, appears a short paper on Tobacco by Dr. Thomas Allen, giving Cuban methods of cultivation and curing.

In the *Gazette* for April 7, 1870, the Governor directed the publication of the terms and conditions under which prizes were offered by the Government of £250 for encouraging the cultivation and curing of tobacco.

† Sir J. P. Grant, Governor, 1866-74.
†Excellent cigars are now made in India. *J. D. H.*
‡Sir A. Musgrave, Governor, 1877-83.

In the Report on the Botanical Gardens for 1871-2, Mr. Thomson says :—

'Plots of Manilla, Havana, Kentucky, and Latakia tobacco have been grown, and samples of them will be sent to England for valuation. The Latakia, which came from Kew a few years ago, I observe, is already very generally cultivated by the peasantry in many parishes, but, like most other cultivated plants in the island, in small patches.

'A great impetus has been given lately throughout the country to the cultivation of tobacco on a much larger scale than formerly. I have, during the last six years, distributed annually at the rate of 200 small packets of five varieties of seeds which were first received from Kew.'

The collector of taxes for Kingston reported on January 2, 1874, that a number of small manufactories of cigars have recently been started in this city, principally by the refugees from Cuba; and although such cigars are very generally made of imported tobacco, yet so much of our own weed is now employed as to affect very considerably the importation of foreign-made cigars.

He further continues as follows :—

'There are also at present in Kingston two large establishments where cigars are manufactured entirely of Jamaica grown tobacco, and one of these large establishments (Messrs. Soutar's) has succeeded in bringing into notice on the continent, particularly in Austria, Prussia, and Turkey, the superiority of our Jamaica cigars to the ordinary brands of Havana; indeed, so excellent have the cigars exhibited by Messrs. Soutar at the Vienna Exhibition of last year been deemed by the Imperial Commissioners, that a medal has been awarded to them for their exhibit.

'I am also informed that some of our best samples compare favourably with the very best Havanas, and that there is every likelihood of a large export trade being established at no distant date, and the cultivation of the weed being extended in this country.

'On reference to Customs' statistics, I find that in the year 1871-2, cigars were imported, amounting to 7,202 lb., whilst in 1872-3, the quantity fell off to 1,963¼ lb., and that the exportation of our island manufacture has increased from 100 lb. in 1871-2 to 494 lb. in the past year.

'It is therefore evident that tobacco will, within a few years, become one of the staples of this island, and will not only displace the imported article, but compete successfully in the markets of the world against all foreign productions of the kind.'

In November, 1874, the Governor directed the publication of the following extract concerning tobacco produced in Jamaica, and exhibited at the Vienna Exhibition, 1873, from a Report by Wm. Robinson, Esq., Special Commissioner for the Crown colonies, and Superintendent of the Colonial Section at that Exhibition, upon the British colonies represented there, with particular reference to their produce :—

'The cultivation of tobacco, according to the Cuban system has made a satisfactory start, and is increasing.

'By the returns of the collectors of taxes, it appears that in August, 1871, there were only 91 acres of this cultivation; there are now more than 300 acres. The increase is principally in the parishes of St. Andrew, where the cultivation is carried on by Jamaica owners, and in the parishes of St. Catherine, St. Thomas, Portland, and St. Mary, where it is carried on mostly by Cubans who have settled and become the owners of property. Both Cuban and native labour are employed in the cultivation, but Cuban labour alone is employed in the manufacture. As yet, the tobacco grown in the island is for the most part made up into cigars and snuff for island consumption. But the reports made of cigars sent by way of experiment to the London market are satisfactory. There can be little doubt that tobacco will soon be a great staple of export. The quality is certainly good. There is nothing to, prevent Jamaica cigars equalling those exported from Havana.

'In 1870, a prize of £250 was offered for the best tobacco, produced in Jamaica by any cultivator of not less than 8 acrese producing 400 lb. of cured tobacco from each acre. This prize was equally divided between two competitors in 1872. These were the first producers in Jamaica of tobacco as an exportabl, article.

'Cigars were the only produce of Jamaica exhibited at Vienna and they received the Medal of merit. Messrs. Soutar & Co., of Kingston, sent 2,000 of different sorts, which were excellent both in quality and in make. They formed quite a feature in the colonial annexe, and five times that number could have been sold as samples had they been placed at my disposal.

'The plantations of Messrs. Soutar are 15 miles from Kingston, and were established four years ago upon a soil similar by analysis and in a climate corresponding with, that of the famed Vuelta Abajo District in Havana. Their seed was also received from, and is of the description grown in, Vuelta Abajo. Their manufactory is in Kingston, where they constantly employ 100 hands in the preparation of the tobacco, and manufacture of cigars and cigarettes. The cost of freight from Jamaica to Great Britain is about 3s. per 1000 cigars, and to the Continent from 3s. to 3s. 6d. Persons disposed to question the value of Jamaica tobacco frequently stated to me that transplanted tobacco changes its character, and that therefore the cigars could not be as good as Havanas. The impression that it changes in character is correct. That delicate aroma found in the Vuelto Abajo tobacco is not derived from the seed but from the nature of the soil, the climate, and the temperature.

'When first establishing plantations in Jamaica some five years ago, Messrs. Soutar were of course aware of this fact, and tried the growth in three different localities, all sown with the same seed, which was obtained from one of Partaja's plantations in the district of Pilotes in the Vuelta Abajo.

'One plantation gave a very good quality, another a tobacco similar to that grown about Santiago de Cuba, and the other a strong but flavourless leaf, each differing according to the soil and climate, although all were cured in the same way. It was not until they had obtained a correct analysis of the soil of the Vuelta Abajo, together with a record of the temperature and other meteorological phenomena, that they met with any degree of success, and indeed it is only now that they have been able to secure a property having all these conditions.

'This year's crop appears better than last, and Messrs. Soutar are confident that the next will be equal to the finest Vuelta Abajo.

'I have had much pleasure in forwarding several large orders to Messrs. Soutar from Vienna, and I am convinced that if, through these orders, they obtain a footing in Germany, a prosperous future will be in store for them.'

Sir John Peter Grant, the Governor of Jamaica, with whose name the increasing prosperity of Jamaica will ever be associated, reports that 'in the Castleton Gardens, plots of Manilla, Havana, Kentucky, and Latakia tobacco have been grown. The first and last of these tobacco plants seem to thrive peculiarly well. The sudden spring that the cultivation of tobacco has just taken in this colony, renders the question of tobacco seed one of great interest and importance. Our garden must possess all the most highly prized varieties of this plant. But from all I can learn, Jamaica has as good a right to send tobacco seed abroad as any other place has. I have heard of a preference being given to the seed of Jamaica plants to seed imported from Havana of the same variety, and I have heard of Cuban settlers here who have pronounced the quality of some leaf now growing here, upon plants where the cultivation happened to have been attended to with the needful care and skill, to be already equal in size and quality to that of the best Cuban leaf.

'For a few years past the Superintendent of our Botanic Garden has been distributing here small packets of tobacco seeds at the rate of 200 packets a year. These packets contain five varieties of seed, originally procured from Kew.

'I cannot mention Kew without observing that infinite as has been the services of Dr. (now Sir) J. D. Hooker to every part of the British Empire, there is no spot in that Empire which has greater reason for gratitude to that eminent man than this island of Jamaica.'

In his Report on the Botanic Gardens for 1873-4, Mr. R. Thomson writes as follows :—

'At the request of the Government, Her Britannic Majesty's Consul-General at Havana forwarded in September a bag of the famous, and scarcely to be obtained, Vuelta Abajo tobacco seed, weighing upwards of 20lb. This made up the quantity I possessed to 30lb., which was advertised for public distribution, gratis. Upwards of 100 applications were made for it, and fifty-four of the earliest applicants received each a packet of about ½lb., the others receiving smaller ones. Many of the applicants stated that they contemplated the cultivation of this product on a large scale, and it is thus to be hoped that millions of plants will be produced from these seeds.

'The successful cultivation of tobacco in Jamaica is now an accomplished fact, and it may be considered one of our staple products. Considering the paucity of the staple products of Jamaica, the desirability of introducing new objects of cultivation and the reluctance exhibited on the part of private enterprise to embark in new undertakings, the position that tobacco has taken is highly gratifying, and augurs well for the future of the island.

'Considerable difficulties have to be encountered in the introduction of a new cultivation; amongst others are a proper selection of soil and climatic conditions, and the ignorance of the peasantry both with regard to cultivation and manufacture, and it is to be hoped that persons entering upon this cultivation will duly consider such difficulties, as there can be no doubt that success will, in a great measure, depend upon their doing so.

'It should be remembered that it is to the Cuban refugees that we are mainly indebted for the introduction of the tobacco cultivation, for it is to their enterprise, and to the advantage that has been taken of their skill, that we must attribute whatever has been done in regard to this. Amongst those gentlemen who deserve the best thanks of the country for their determined and persevering efforts to establish this important industry, I would mention the name of Simon Soutar, Esq., whose beautiful cultivation of 100 acres of tobacco does him great credit. With regard to another gentleman who has also taken a leading part in the establishment of this plant, I have great pleasure in extracting the following valuable notice from the *Journal of Applied Science*, the editor of which is a high authority on colonial vegetable products. A writer in that journal, treating of the importance of colonists, in view of the increasing competition in the production and manufacture of the great staples, turning their attention to minor products, makes the following remarks with regard to tobacco:— "The Spaniards have hitherto monopolised this trade, alleging that parts of the soil of Cuba were alone suited to the production of the Havana tobacco. This assertion is now disproved, for with good choice of seed, soil, curing of the leaf, and skilled manufacture of the cigars, Jamaica now sends into the market as excellent a cigar as was ever shipped from Cuba, and at a far cheaper rate. We have lately been favoured with samples of excellent cigars from the estate of Count Jose Duaney, Jamaica. He was among the first to introduce the planting of the real Cuban seed there and his estate, Hall Head, which is in a district in the east of the island, has produced the best cigars up to the present time, although many other estates have gone into tobacco culture. If the quality of this brand be maintained, and the remarkably low price at which they can be sold wholesale continued, it will be a real boon to smokers, and lead to extensive orders."'

Mr Simon Sontar has favoured me with the following excellent account of his connexion with the rise of the industry. The knowledge of the capabilities of Jamaica as a competitor of the Vuelta Abajo district in Cuba, is doubtless in great measure due to Mr. Soutar's energy and perseverance :—

'In 1863 I was in Havana and was struck with the great prosperity of the tobacco industry and the great influence it had on the commerce and prosperity of that port. In those days Peru with its guano deposits, and Chili with its silver mines were very prosperous, and along with London took the entire crop of the finest cigars made, regardless of price ; and while I was there the wharves were lined with cases of the finest cigars being shipped to those markets. On every hand I saw at least one-half of the prosperity of Havana assured from its proximity to the great tobacco district, the Vuelta Abajo. I tried to get some seed then but failed, and what I got a year or two afterwards appear to have been fried as it failed to germinate.

'At the close of the American war, a Kentuckian, Capt. Field, who had served with the Confederate Army, came to Jamaica and posed as a Kentucky tobacco planter. I started him on "Bellevue," owned by the late O. M. Feurtado, but then the property of Mr. Derbyshire.

'Capt. Field got seed from Kentucky and grew tobacco, but it was a long leaf and suitable only for smoking purposes. About 1868 or 1869, we got some Havana seed, through Sir J. D. Hooker and the Superintendent of Public Gardens, with which I started cultivation with Capt. Field, at Bellevue and with Pedro Cisreros, a Cuban from Manzanilla at Cherry Garden, now the residence of Major Marescaux. The tobacco grew very well but had no Vuelta Abajo flavour. I next tried the banks of the Rio Cobre at Cross Pen and several other places but without satisfactory results. Meantime I thought the Wag Water Valley both in soil and meteorological conditions similar to the Vuelta Abajo, and procured a sample of soil which was sent to Pelletier, the celebrated French Chemist for analysis. It was found to be very much like a similar sample already analyzed by the same chemist from the Vega Pilotos, a rather celebrated vega belonging to Partagas & Co. I secured some land at Temple Hall in 1870, but being late, very little was done that year, and it was not until 1872, when I got Jose Pita, a planter from the Vuelta Abajo, that I was able to produce a tobacco equal to Havana. In that year I got about twenty of the best Havana cigarmakers, revolutionists who came to Jamaica as refugees—Sestero, Badell, Pino and others, all celebrated workers from the factories of Partagas, Cabanas and "La Honradez." They made the cigars exhibited at the Vienna Exhibition in 1873, and which gained the highest Medal and Diploma, and secured orders from Prince Milan, (afterwards King of Servia), the Sultan of Turkey, and a number of other notables who considered them better than the usual run of Havana cigars of that day. The Commissioner in charge of the Colonial Section of the Vienna Exhibition was Mr. William Robinson (afterwards

Sir W. Robinson, (Governor of Trinidad) from the Colonia lOffice Downing Street, who took a very great interest in the exhibit, and my success was no doubt greatly due to his good and judicious management. I exhibited again in 1876 at the Centennial Exhibition, Philadelphia, taking the highest honours and medal, in many instances higher than Havana competitors.

'The Government prize of £250 given for the encouragement of the tobacco industry was equally divided between Mr. Derbyshire and myself, that being in the opinion of Messrs Kemble and Trench the best way of encouraging the industry. A subsequent prize of £50 given by the London Chamber of Commerce was awarded to B. & J. Machado for a sample of Temple Hall tobacco. I have sold Temple Hall tobacco in Jamaica for £25 a quintal and in Bremen, then the greatest tobacco market in the world, at 5s. a pound. Some Cherry Garden tobacco was sold in London by Grant Chalmers & Co. at 3s. 6d. a pound.

'Tobacco being a garden cultivation requires constant attention and supervision. It necessitated my living at Temple Hall and spending three days a week there, coming into town on Tuesdays, Thursdays and Saturdays, and also neglecting my town business to a great extent. Then a number of people had by this time gone in for the cultivation of tobacco and manufacture of cigars and were flooding the foreign markets with questionable Jamaica cigars to my prejudice, so I gave up the factory in favour of the Machados, renting the lands to Cubans.

'The system of cultivation pursued now, is that of the Vuelta Abajo, and can never produce a high-class tobacco. It shows that our tobacco is good when with such treatment we are able to produce a smokable cigar, but if they would only get some good Vuelta Abajo planters and grow the tobacco in the proper localities with the same careful cultivation and selection that obtains in the Vuelta Abajo, our cigars would compete with, if they did not excel Havanas. The Vuelta Abajo lands were supposed to have deteriorated very much. During the time they were using large quantities of Peruvian guano their tobaccos lost the dry nutty flavour they had in the sixties. Then as the demand increased and the manufacturers were unable to fill all orders, they resorted to Porto Rico and Sumatra tobacco which have no Havana flavour.

'I always found the Department of Public Gardens and Plantations very ready and anxious to help the tobacco industry, but it must be grown much as the cotton is grown in the Southern States, by families dependent upon results, who cultivate small holdings, giving them constant care and attention.'

In the Report on Public Gardens for 1876-7, it is stated:—A small packet of Bhilsa tobacco seed was received last year from the Royal Gardens, Kew. This is the most highly reputed of all the Indian kinds: only a few plants were raised: these it was necessary to reserve for seed bearing. They made an extraordinary robust growth and otherwise presented many of the characters which gave value lo the best varieties of tobacco. About 2lb of seed was saved which I distributed among the principal growers on the island for their trial and report.'

Messrs Charlton Thompson and G. A. Weitzman cultivated tobacco from 1875 to 1884 in Jamaica; they had 150 acres at Potosi and 50 acres at Morant in the Blue Mountain Valley in the parish of St. Thomas, and 50 acres at Colbecks near Old Harbour in St. Catherine. They used Sumatra, Java, and Havana seed, but the best results were from Havana.

The following memorandum furnished to the Governor (Sir A. Musgrave) by Mr. Weitzman, was published in the Report of the Botanic Gardens for 1878:—'The results obtained by different planters are, as is well known and admitted, even by Cubans not interested in this undertaking, of the greatest importance, and have proved beyond a doubt that our produce is one worthy of attention, and one which will stand competition with that of other countries, the reputation of which has been established long before. As the result of my journey to England and Germany last year, I may mention that in the Hamburg market, the most considerable in the world for tobacco, I found that our produce stood next in rank to the Havana tobacco, to which it was pronounced inferior, but superior to all other kinds, even not excepted those other parts of Cuba, such as St. Jago, Manzanillo, Yara, etc., which furnish such a very considerable quantity to the consumption at home. . . . .

'As for the outlet and sale of our produce, every one interested has found that the German markets, especially that of Hamburg, has given it the best reception and greatest encouragement. Our tobacco is readily sold there, and, though the first hands may buy it as Jamaica, the consumer in most cases will not know better than that it is Cuban or even Havana. . . . .

'Jamaica has shown that it can produce a tobacco which has proved itself worthy of being introduced as a new article of industry, and, considering the short time that has elapsed since it was first established as such, we have gained a by no means small success. Whatever faults there may exist about the different branches, there are none which time cannot overcome.'

In his first Report (1879-80) as Director of Public Gardens and Plantations, Mr. (now Sir) D. Morris quotes from Mr. Weitzman as follows:—

'There are very encouraging signs of a steady demand for our cigars in England, as well as on the Continent of Europe. In the German markets, which are considered the most important for leaf tobaccos from all parts of the world, Jamaica tobacco sent there for sale was well thought of and ranked in price next to the celebrated Havana leaf, as it distinguished itself from most of the other Cuban varieties, by its fineness of texture and mild agreeable flavour, and an absence of all rankness so often met with in the latter.

'Since last year, the consumption of Jamaica cigars in England has spread in an extensive manner, and the demand for our production now gives employment to a great number of hands. Of the workmen that are employed, by far the larger number still are Cubans, but we are glad to see the natives gradually adopting the profession and taking part in the general competition.'

In the Report for 1883-4, the Director says: 'The cultivation of this once promising industry on a large area would appear to be decreasing, chiefly owing, I believe, to want of success in properly curing and preparing the crop for the market.

'In many parts of the island, however, tobacco growing in small patches is being extended gradually, and numerous applications are made for the best qualities of Havana tobacco seed.

'As is usual, not only in Jamaica but in most of the West India Islands, there is a great want felt for plain practical hints as to the cultivation of new economic plants, and the preparation of the produce so as to gain good and remunerative prices.

'On the subject of properly curing tobacco, which is one of the most important points connected with this industry and one, moreover, in which most Europeans who have attempted it in Jamaica have failed, there is a great demand for reliable information. The Cubans settled in the island are apparently the only persons who can cure tobacco properly, but unfortunately, their numbers are decreasing, and in many cases they take up other industries which appear to them to offer better returns for their labours.'

He also quotes from a communication to him from Dr. Neish as follows: 'General Vijegas, formerly of Cuba, but now an extensive cultivator of Havana tobacco at Colbeck's Plantation,* informs me that sowings of tobacco seed are usually begun in August with successive sowings throughout the following months, namely, September, October, November, and December, and mentions that the earlier sowings give leaf of very mild quality, with fine flavour, and that the later sowings furnish stronger tobacco, the leaves gaining in strength with the advancing season. The very strongest kinds are furnished by plants sown in November and December. His opinion is that there are in Jamaica many thousands of acres well adapted for the cultivation of Havana tobacco, and that, contrary to a common opinion, the drier parts of the island, provided suitable soil be selected, are quite well adapted to tobacco. He maintains that it is only in the season of planting out that much moisture in the soil is essential; that tobacco grown in a comparatively dry district will have a fine and distinct flavour, different in aroma to that grown in a wet locality. Further, I have his authority for the observation that tobacco grown in wet districts, such as parts of the eastern end of the island, and in some northside parishes, will not keep long, but must be sent to the European markets as soon as it can be cured, and that cigars made of such tobacco will not keep for more than a year without deteriorating, both in

* Near Old Harbour, St. Catherine, Jamaica.

appearance and quality, whereas tobacco grown in a drier climate will keep longer, and cigars made from the latter kind will keep for fully three years. His opinion is that there is a very general liking amongst English smokers for cigars mild as to strength, but delicate in aroma—a taste which is met by well-known and well-cured Havana tobacco grown in a rather dry but not arid climate. He says there is plenty of good soil in Jamaica, at present in ruinate, perfectly adapted to grow this quality of tobacco, ranging over an extensive tract of country comprised principally in the parishes of St. Catherine and Clarendon.'

In 1884, Messrs. Thompson & Weitzman failed, their Agents in England having overtraded and their capital having become exhausted.

In the year 1888, the London Chamber of Commerce offered a prize of fifty guineas for the best specimen of tobacco grown in India or in any of the British colonies and possessions. Each specimen submitted was to consist of a minimum quantity of 400 ℔. in weight. The prize awarded in the following year was divided between samples from Jamaica and British North Borneo. The Jamaica winner was the firm of Messrs. B. & J. B. Machado, whom I persuaded to enter for the competition.

As the Cubans alone, speaking generally, understood the art of cultivating and curing tobacco, any increase of the industry among the native small settlers could only be successful and permanent if reliable and practical information could be given in a form that could be assimilated by them. An attempt in this direction was made in 1889 by the publication of a short treatise on tobacco in the Jamaica *Bulletin* by Mr. J. C. Espin, a Cuban.

In 1893, 25 ℔. of the best Vuelta Abajo seed was obtained from the British Consul-General in Havana and distributed to growers, and other consignments were received from time to time in subsequent years.

In 1897-8 and in the following year tobacco was grown at Hope Gardens for the express purpose of obtaining a large stock of seed from carefully cultivated and well grown plants both of Havana and Sumatra varieties.

During the years 1898-1901, a very important experiment in cultivation on a large scale was undertaken by the Hon. Evelyn Ellis at Montpelier in St. James. No less than 150 acres were cultivated in tobacco, and no expense was spared to make the experiment a success. A short account of this undertaking was published in the Jamaica *Bulletin* for January 1899. Other Industries were under experiment at the same time, such as dried bananas, and cattle food, under the management of Mr. Zurcher. But none of the experiments appeared likely to yield a profit, and they came to an end in the year 1901. Some excellent tobacco and cigars were produced, but the soil is not of the proper physical texture to give really good results.

In the Annual Report for 1898-9, I wrote as follows: 'The engagement of an expert in curing tobacco at Montpelier at a high salary is justified as a mere matter of business. It would be a great boon to the whole island, if an expert of like character could be attached to the Hope Gardens to demonstrate in his work there to all comers the manifold minutiæ of the process of curing. When there was no work that required his presence at Hope, he could travel through the island, giving public demonstrations, examining tobacco undergoing curing at different estates, and affording advice and assistance in every way to any who should seek it.'

'At present our means of instruction are very limited, but every one who receives seeds may also have the Jamaica *Bulletin* (May, 1889, No. 13), written by a Cuban expert, dealing with the cultivation and curing of tobacco.'

Obtaining an expert knowledge of the curing of tobacco was rendered possible when Mr. T. J. Harris was apppointed Assistant Superintendent of Hope Gardens with the special care of the economic section. In 1900-1, about 4 acres of tobacco were grown at Hope Gardens for the purpose of investigating the proper methods of cultivating and curing. A curing house was built and an attempt made by Mr. T. J. Harris to cure the leaf from the study of Espin's treatise and from information received from Cubans. The first cutting failed, and an arrangement was then made with a Cuban tobacco planter, Mr. Antonio Leon, to come to Hope Gardens from time to time and advise on the cutting and curing of the crop. Four acres were again planted in the following season (1901-2), and from the experience gained during the two seasons, Mr. T. J. Harris was enabled to prepare articles on the cultivation and curing of tobacco for publication in the Jamaica *Bulletin*. These articles appeared in the *Bulletin* for April, May, and October, 1902, and were also issued as leaflets for general distribution. The different value to be placed on the two treatises—the one by Mr. Espin and the other by Mr. T. J. Harris—may be expressed by saying that Mr. Espin wrote as one familiar with the subject from boyhood, and so unconscious of the difficulties of the inexperienced; Mr. Harris wrote as one who had failed over and over again, and who had only gained his knowledge by careful study of the information received from Mr. Leon and other Cubans in correction of details of practice which had caused previous failures.

I attach great importance to having been enabled by the Government to secure that one of the staff should have had the opportunity to qualify himself as an expert in tobacco. His experience was put in writing for the benefit of others; men were trained by him in the Department who have carried on the work since he left, and a practical school for teaching the apprentices and others was started at Hope Gardens which ought to exercise a very great influence on the extension and improvement of the tobacco industry in the island.

As stated in the Report for 1898-9 I consider that besides the practical training which is now going on at Hope Gardens, it would be well to have trained men travelling through the country during the tobacco season offering advice to growers in cultivation and curing. Large growers can always secure the services of a Cuban, but small settlers require demonstrations in their tobacco fields and in their curing houses to supplement and to illustrate the teaching imparted in the leaflets on tobacco.

In 1902-3, only two acres were planted for the purpose of giving the apprentices an opportunity of gaining practical experience; and in the following year 1903-4, besides 2 acres in Havana tobacco, $\frac{1}{4}$ acre was grown in Sumatra tobacco under a cheese-cloth tent to test whether the very expensive Sumatra wrapper imported from America could not be grown in Jamaica. The result of the experiment was to show that uuder cheese-cloth a very fine grade of wrapper can be grown, quite equal if not superior to that imported from America. Owing to the dryness of the climate at Hope, difficulty was experienced in curing, but this was overcome on further trial during the following season (1904-05). During the next year (1905-6) the Sumatra tobacco was grown in the open as well as under cheese-cloth, and the opinion of an expert, Mr. F. V. Chalmers, was that the sun-grown Sumatra was superior to that grown under cloth, and that the flavour of both kinds and of the Havana is 'unsurpassable when fully fermented.'

A small sample of the Sumatra tobacco grown under shade cloth was sent for report as to quality and value in the English market to the Imperial Institute in the year 1905. The Director, Prof. W. R. Dunstan, reported as follows:—

'The sample consisted of six leaves of the *wrapper* type of cigar tobacco showing a dull, olive brown tint. The leaves were of fair length, uniform in colour, thin and free from stains and burns. They were somewhat brittle when handled, but this was probably due to their having been packed between sheets of cardboard which had absorbed the moisture, rendering the leaves abnormally dry. When ignited, the tobacco burned evenly and steadily evolving a fairly fragrant aroma and leaving a greyish white ash.

'As the sample was very small, it was impossible to submit it to chemical examination. It was therefore sent to a firm of tobacco experts to be tried for *wrapping* cigars and for the determination of its commercial value. The experts' report on the tobacco was as follows:—

"The tobacco is of a very handsome appearance, thin in texture and therefore highly productive as a *wrapper* for tobacco; in use it is somewhat *tender* and does not appear to have quite as much elasticity as Sumatra tobacco of similar texture; the burning is very fair and the flavour not unsatisfactory. Similar tobacco well put up, would fetch on the English market up to about 3s. per lb. for first lengths, say 2s. 3d. per lb. for the second lengths, and from 1s. 3d. to 1s. 6d. per lb. for the third lengths.

"We feel sure that the soil and climate which have produced this tobacco, are suitable for growing *wrapper* tobacco, equal to most in the world, and if labour is plentiful and cheap, and the area of suitable ground large enough, there is a chance, in time, of this district of Jamaica becoming a serious competitor of Borneo Sumatra and Java.

"It will, however, be advantageous to prepare tobacco of this class in a similar manner to that in which East Indian tobaccos are got up for the European markets. If it were put on the market in the same form as the Mexican Havana, and other West Indian tobaccos, this would probably detract considerably from its value."

'The experts go on to suggest that it might be worth while to carry out a similar cultivation experiment in Jamaica with Java tobacco as this would probably yield a *wrapper* leaf, which would be stronger in texture and of even better flavour than the present sample.

'The results of the experts' trial of this tobacco show that it is of good quality and that if a similar quality can be placed on the English market in quantity it will probably realize remunerative prices.'

As Mr. T. J. Harris was able by his experience to prepare notes for the use of others in cultivation and curing Havana tobacco so his successor, Mr. W. M. Cunningham, with experience of two crops of Sumatra tobacco, prepared notes for the use of those who are about to grow Sumatra seed for wrappers. These notes were published in the Jamaica *Bulletin* for July 1905.*

The following tables showing the quantities of cigars, tobacco, etc., imported into, and exported from, Jamaica during the years 1871-1906, together with their estimated values, are of considerable interest :—

* The notes prepared by Messrs. T. J. Harris & W. M. Cunningham were reprinted as *Pamphlet No. 38* of the Imperial Department of Agriculture.

TABLE I.

IMPORTS OF CIGARS, TOBACCO, ETC., INTO JAMAICA DURING 1871–1906.

Year.	Cigars.		Leaf.		Manufactured.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
	lb.	£	lb.	£	lb.	£
1871–2	7,202	2,880	137,759	5,165	133,805	14,271
1872–3	4,111	1,644	173,820	6,518	97,547	9,754
1873–4	2,253	901	128,006	4,800	95,795	9,579
1874–5	1,512	604	168,163	6,306	154,523	15,452
1875–6	1,536	774	171,120	6,417	73,249	7,335
1876–7	1,043	483	125,807	4,718	102,114	10,211
1877–8	1,485	607	139,950	5,506	143,771	12,821
1878–9	902	496	113,474	4,728	80,570	6,043
1879–0	531	318	111,757	4,191	112,992	7,533
1880–1	990	519	139,574	5,234	94,918	7,119
1881–2	392	267	89,080	3,526	76,473	5,736
1882–3	566	346	129,028	5,376	97,182	7,346
1883–4	496	334	127,537	4,778	83,736	6,367
1884–5	1,016	647	123,679	4,638	87,848	5,490
1885–6	657	730	99,934	3,748	88,131	6,786
1886–7	507	428	103,921	4,330	119,187	9,927
1887–8	189	163	124,556	5,190	93,477	9,138
1888–9	432	319	119,875	4,496	114,322	11,237
1889–0	98	106	56,511	2,119	73,107	6,619
1890–1	586	360	152,911	5,734	135,411	12,711
1891–2	229	518	115,845	4,344	125,727	12,059
1892–3	224	139	132,505	5,521	149,833	14,547
1893–4	302	218	141,943	5,914	154,111	16,256
1894–5	152	87	116,496	4,854	122,578	12,729
1895–6	69	65	136,038	5,668	158,193	11,865
1896–7	41	31	116,114	2,903	135,536	12,965
1897–8	58	29	110,157	1,836	136,886	10,153
1898–9	170	60	85,062	1,418	128,429	11,289
'99–1900	22	13	81,264	1,354	43,609	2,180
1900–1	36	30	49,898	832	94,974	9,705
1901–2	69	51	64,722	1,078	106,748	10,933
1902–3	28	17	45,880	765	98,403	10,281
1903–4	37	26	50,121	835	96,153	9,975
1904–5	88	106	40,443	674	82,449	8,640
1905–6	153	154	59,614	994	117,075	12,668

TABLE II.

EXPORTS OF CIGARS, TOBACCO, ETC., FROM JAMAICA FOR 1871–1906.

Year.	Cigars.		Leaf.		Manufactured.	
	Quantities.	Values.	Quantities.	Values.	Quantities.	Values.
	lb.	£	lb.	£	lb.	£
1871–2	100	25	...	...	...	...
1872–3	317	55	896	48	...	...
1873–4	2,733	537	5,600	455	...	...
1874–5	367	162	26,723	1,810	...	...
1875–6	2,633	283	81,510	4,054	...	...
1876–7	2,082	621	68,239	4,030	...	...
1877–8	3,171	757	54,314	5,585	...	...
1878–9	3,796	1,423	135,051	8,441	...	...
1879–0	9,826	4,913	35,271	1,323	...	...
1880–1	25.928	13,612	77,007	2,569	...	...
1881–2	9,216	10,088	85,365	4,268	...	...
1882–3	4,741	2,398	22,990	1,029	...	...
1883–4	4,993	2,122	6,662	333	...	...
1884–5	4,690	1,993	2,019	156	...	...
1885–6	4,509	2,029	520	25	...	...
1886–7	4,252	2,126	350	17	...	...
1887–8	7,008	3,504	...	...	...	...
1888–9	4,479	2,800	1,593	79	...	...
1889–0	4,193	2,096	...	...	...	...
1890–1	10,892	5,446	...	...	...	...
1891–2	18,858	9,429	990	34	...	...
1892–3	10,235	5,117	...	...	...	...
1893–4	13,747	6,873	...	...	...	...
1894–5	17,469	8,824	...	...	...	...
1895–6	15,297	7,648	...	...	...	...
1896–7	19,960	9,980	...	...	...	...
1897–8	27,966	13,983	38,643	2,648	9,729	1,459
1898–9	30,592	13,129	24,525	1,214	31,520	2,889
'99–1900	30,009	11,530	85,932	4,387	12,735	1,502
1900–1	44,726	15,654	101,350	5,067	17,404	1,958
1901–2	39,122	11,904	47.889	2,394	13,759	1,548
1902–3	41,888	17,590	4,824	157	19,462	2,614
1903–4	34,428	16,752	12,109	582	17,035	2,233
1904–5	35,438	18,372	15,775	613	23,791	3,289
1905–6	40,325	20,312	6,554	246	11,261	1,251

LAWS.

In the year 1897, the Government imposed an excise duty on cigars and cigarettes manufactured in the island, and charged also a duty for licenses for manufacturing and retailing.

The Cigars and Cigarettes Law of 1897 enacted—that manufacturers of cigars and cigarettes should be licensed, and pay a duty of 20s. on every 100,000 cigars made, and 5s. on any number of cigarettes; that every retailer shall take out a license, paying a duty of 5s., for every place of business, and shall enter into a bond; that manufacturers shall pack cigars and cigarettes in such receptacles as are approved by the Governor-in-Privy-Council, to which a stamp shall be affixed; that importers of cigars and cigarettes shall affix a stamp to each package; and that an excise duty be imposed and payable by means of stamps at a rate for cigars of 6d. per 100 retailed at a price not exceeding 8s. 4d. per 100, of 2s. per 100 when retailed at a higher price, at a rate for cigarettes of 1d. per 100; and provisions for bonding and for keeping books.

This law came into operation on June 20, 1898. The provisions of the new law were felt to be onerous by those engaged in the industry, and the results were disappointing to the Government. The Collector General in his Annual Report for 1898-9 states:— 'The newly levied duty on cigars and cigarettes between June 20, 1898 (the date of the coming into operation of the law) and March 31, 1899, yielded £2,543 or at a rate of about £3,400 a year. I am free to confess that I am disappointed at the return from this source of revenue, and at the reception the law met with on its being put into operation. Everyone admits that cigars form a legitimate object of taxation and that the duty imposed is a light one, and well within the ability of consumers to pay, and the methods of enforcement were practically those in force elsewhere, where excise restrictions exist; yet as soon as it was sought to put the law into operation, it met with most strenuous opposition. By relaxing many of the provisions of the Statute, the Department has striven to collect the duty without friction, but it is manifest that without a modicum of co-operation on the part of those concerned, the law must either be a practical dead letter; or the alternative is for the Department to enforce it rigidly; and this would create friction and possible hardship. If a method can be found whereby the restrictions on the trade are removed while the duty, which is admitted to be a proper impost, can be brought into the exchequer, there will be no longer any appearance of excuse for opposition to the law.'

The area of cultivation in 1898-9 in St. Andrew and St. Catherine fell off considerably—a large number of Cubans having left the island. This exodus was no doubt partly due to the close of the Spanish American War, but probably it was largely increased by inability or lack of desire to conform with the restrictions on the trade imposed by the new law. The Government decided to alter the law in certain particulars, and the Tobacco Duty Law of 1900 was passed, which repealed the law of 1887, and placed the duty on getting a license at 5s. per 10,000 cigars; at 5s. for any number of cigarettes; added a duty of 5s, for the preparation of any amount of pipe tobacco; changed the excise duty for cigars to 1s. per 100 for all kinds, for cigarettes to 1d per 100, and added 6d. per lb. for pipe tobacco, made provision for keeping a stock book and a record of tobacco used, for making monthly returns and for checking same by the collector; removed duty on exports of tobacco, cigars and cigarettes.

The Tobacco Duty Law of 1902, while still providing for licenses for manufacture and sale, abolished the duty on licenses; placed the excise duty for cigars at 3d. per 100 when retailed at a price not exceeding 5s. per 100, at 1s. per 100 for cigars selling at more than 5s. per 100, for cigarettes at 1d. per 100, for pipe tobacco at 6d. per lb.

COST OF CULTIVATION FOR LARGE GROWERS.

A planter in Upper Clarendon who has cultivated 6 acres in the season 1905-6, states that the actual money spent on cultivation, curing and erecting a tobacco curing house was £238s. 2s. He estimates that £40 should be added to this for fencing, use of stock and implements, the timber for the house, and cases for shipping the crop, not charged in above, making the total expenditure for the first crop of £278 2s. 0d.

But part of this expenditure should be spread over, say, six years—clearing the land, preparing and fencing the field, felling timbers, erecting and roofing tobacco house, etc.,—say, £90.

For this reason, deduct £75 from £278, making the cost of cultivation and curing of six acres £203, or nearly £34 per acre.

It is admitted that in keeping the field in first rate garden cultivation all the time, more money was spent than was necessary. On the other hand, no charge is entered for supervision; and the wages of a man sufficiently qualified to grow, cut, and cure tobacco would amount to 30s. a week at least, while the work lasted from November to June.

At Hope Gardens insect pests are not troublesome, but in the cultivation under discussion a constant gang of labour had to be employed—picking worms and caterpillars from planting to cutting. This expense would probably not be so heavy in succeeding years, as the ground would be free from weeds, decaying roots, etc. No rent or taxes are included in the above statement.

The same planter writes: 'In my previous experience, taking good average years, and with all the economy that can be practised, cigar tobacco—carpa and tripa unclassified—cannot be *grown* under 6d. per lb., and I am under-, rather than over-,stating the cost. In unfavourable circumstances, and a light crop, it will cost double that."

Another planter with considerable experience of tobacco grown at Colbecks in St. Catherine and elsewhere says; 'It is impossible to grow and cure tobacco of the Cuban variety in Jamaica and to put it f. o. b. at less than 9d. per lb.'

(*b.*) *By Cuban Small Growers.* The cultivation by Cubans is carried on by themselves and families and hired Cuban labour.

The cost is calculated at £12 per acre for land previously worked, and at £15 per acre for land covered with trees and bush. The yield is from 600 to 800 lb. per acre. Their own labour is calculated at the value of hired labour. Another estimate is that every 100 lb. of tobacco costs them £2 to £2 10s.. according to the season. The third quality (fonque) amounts to 50 or 60 lb. per acre, and only gets a very small price.

Both wrapper and filler are purchased together at the same price, which ranges from £3 10s. 0d. to £4 per 100 lb.

It would therefore appear, from evidence received, that the large grower who has to employ a special manager for his tobacco will have to pay for cultivation and curing, on an average, 9d. per lb. for his crop of cured tobacco; the Cuban who looks after his own cultivation and curing may reckon on his crop costing him 6d. per lb.

PROSPECT OF THE INDUSTRY.

At present prices, it does not pay large growers to cultivate tobacco and sell the leaf. Even at 1s. per lb. there is not sufficient profit to tempt planters to embark in an industry that requires the very closest attention.

Tobacco for Navy. Mr. F. V. Chalmers has been most assiduous in working out a proper blend of tobacco for use in the Navy, and hopes to create a demand for a very large quantity of Jamaica tobacco at 7d. per lb. Probably all the best of the third quality (fonque) would answer the purpose, and if so, this price is about double what is usually received for it, and would be a boon to tobacco growers. Tobacco of this quality would, however, only amount perhaps to one twentieth of the total crop, and could not amount to a large quantity for some years, until the industry is much extended.

Manufacture of Cigars. It would seem that there might be a profitable outlet for planters for their crop if they were to combine the manufacture of cigars with the cultivation.

There are however great difficulties to be overcome, among which are the following:—

(*a.*) To ensure an even grade of cigars it is necessary to have large stocks of tobacco from different localities for blending; so that planters would have to purchase largely, and great judgment, only acquired by long practice, is necessary to select the proper grades of leaf.

(*b.*) To obtain a market for cigars. The local market is already supplied by those who have been in the trade for some years. The general markets in England and elsewhere are at present practically closed against our cigars, which can only be sold by arrangement with private purchasers, such as clubs. No private grower is likely to gain anything but disappointment in efforts to dispose of his cigars.

Sumatra Leaf. If, however, the present experiments in growing wrapper leaf from Sumatra seed, initiated by the Public Gardens

Department, be successful on a large scale, the crop would find a ready sale and be profitable.

Extension of the Industry by Small Settlers. There has been a great demand lately for seed, and small settlers are experimenting with tobacco in all parts of the island. It is an excellent product for the small grower, but he should first satisfy himself that he has the right soil and climate, that he can devote himself almost exclusively to it during the months of cultivation and curing, that he can afford to erect a proper curing house, and that he will have a market for the cured product.

BOARD OF AGRICULTURE.

Extracts from Proceedings.

The usual monthly meeting of the Board of Agriculture was held in the Committee Room, Headquarter House, on Wednesday, 15th January, 1908, at 2 p.m. Present: the Island Chemist, the Acting Director Public Gardens, Messrs. D. Campbell, C. E. de Mercado, E. W. Muirhead, Conrad Watson, and the Secretary, John Barclay.

The Chairman, Hon. Clarence Bourne, being engaged at a meeting of the Legislative Council, Mr. de Mercado was asked to take the chair.

Cotton—The Secretary read letter (a) from the Colonial Secretary acknowledging receipt of Mr. Watson's memorandum, the views expressed in which the Board had accepted as their views.

The Secretary asked leave to read a letter from Mr. Shore, addressed to him as the Secretary of the Agricultural Society, and which he submitted as the matter of cotton growing had been dealt with more particularly by this Board.

Mr. Shore protested against any arbitrary time being laid down for planting cotton, and against Sea Island Cotton being forced upon them, when in his experience, Egyptian Cotton had given four times the yield and was not troubled by insect pests. The Secretary was instructed to reply that only general instructions had been given as to the time of planting which would suit most of the districts suitable for cotton, viz.:—the same time as corn is usually planted in the district, and that experience so far indicated that Sea Island Cotton is the variety that it would be most advisable to grow.

2. The Secretary tabled cotton bolls affected by Black Boll. Mr. Watson said that this trouble was common wherever cotton was grown, that it was due to too much moisture when the bolls were formed, and that there was no cure, but efficient drainage would largely prevent it. This information was directed to be brought to the attention of the Instructors.

3. *Arrowroot*—The Secretary reported that the Superintending Medical Officer had given permission to store barrels of native arrowroot intended for the supply of Public Institutions in the Island Medical Stores.

Agricultural Conference—The Secretary read a letter from the

Colonial Secretary's Office acknowledging receipt of the Board's views *re* representatives at the Conference.

The following letters from the Colonial Secretary's Office were read :—

Indian Cattle—(a) Enclosing copy of letter addressed to the Agricultural Society intimating that as permission had been given to import cattle direct from India for "Government Purposes," importations for private parties could be treated as for Government purposes by importing through the agency of the Government, first giving notice to the Colonial Secretary.

Importation of Seeds and Plants—(b) Intimating that the prohibition against importing seeds, plants, or soil from Natal, South India, Ceylon, Mauritius, Java, and Fiji had been withdrawn, but that all such importations must be fumigated on arrival here.

Camera—An application by the Chemist for permission to purchase a second hand Camera for use in photographing experiment plots was authorised.

Chemist's Report—The following report from the Chemist was submitted :—

Result of Agricultural Scholarship Examination recommending G. L. Gibbs and E. F. Bailey for Scholarships and asking that E. J. Gregory who had passed the entrance examination be remitted the usual fees. The Chemist's recommendations were agreed to.

Reports from Director Public Gardens—The following reports from the Director of Public Gardens were submitted :—

(a) Hope Experiment Station.
(b) Instructors' Reports and Itineraries.

Port Royal Mountains Agricultural Society—The Secretary read a letter from the Secretary of the Port Royal Mountains Branch, sending a resolution alleging neglect of that district by the Instructor and in the last Prize Holdings Competition. The Secretary explained that the Prize Holdings Competition for 1908 included St. Andrew as one of the parishes and he would try to arrange that the Instructor give Port Royal Mountains district close attention.

The Board would also remember that they had instructed Mr. Briscoe to give special attention to Cotton growing in lower St. Andrew and to Cocoa interests in St. Thomas-in-the-East even if he had to give less attention to other districts.

The following papers which had been circulated but had not been submitted to the Board were now submitted.

School Gardens—(a) Letter from Superintending Iuspector of Schools *re* School Gardens referred from Colonial Secretary's Office.

After discussion it was resolved to recommend to the Government that School Gardens be made compulsory as an essential part of the Code, as necessary as any item of education, and be provided for accordingly.

Vanilla—(b) Letters from the Rev. John Maxwell to the Director of Public Gardens and the Secretary, containing full reports on his special visits to parts of North St. Elizabeth in the interests of Vanilla cultivation.

The remarks of the members on these reports strongly recommended continued efforts for the encouragement of vanilla cultivation as a minor industry in those parts where it grows so readily.

The Sccretary was instructed to communicate the thanks of the Board to Mr. Maxwell for his efforts, and pay him the sum arranged for his travelling expenses.

The following papers, which had been before the Board and circulated for further consideration, were now submitted for final consideration :—

(a.) Estimates Department of Public Gardens. These were approved.

(b.) Hope Experiment Station.

(c.) Reports and Itineraries of Instructors.

(d.) Report of Superintendent of Field Experiments. This was directed to be sent on for the consideration of the Governor.

(e.) Re-organisation of the Laboratory Staff. The Chemist's arrangements were approved and the Secretary was instructed to inform the Government for sanction.

(f.) Letters re Cotton. The application of Mr. H. M. Farquharson for the loan of a hand gin was granted, and the application of the Vere Estates Co. (Ltd.) for loan of the cotton baler, now with Mr. Sharp, was also granted, and the Secretary was instructed to arrange for both.

The usual monthly meeting of the Board of Agriculture was held at Headquarter House on Wednesday, 12th February. Present :—Hon. H. Clarence Bourne, Colonial Secretary, in the chair, Hon. Director of Public Gardens, His Grace the Archbishop Messrs D. Campbell, C. E. de Mercado and Conrad Watson.

Mr. Bourne said that he had intimation from the Secretary that owing to illness he was unable to attend. Apologies for absence were read from the Island Chemist and Mr. E. W. Muirhead.

The Archbishop asked leave to bring forward a motion with regard to the appointment of a Commercial Agent in London. He said he was aware that efforts had previously been made to procure such an appointment and there had been lengthy discussions, but nothing had been settled. He then read the following resolution :—

"That the reports and resolutions adopted some time ago by this Board on the subject of a Commercial Agent in England be formally presented to His Excellency the present Governor; and that he be asked to receive a deputation from this Board in order that opportunity may be given for explaining the precise objects and methods which the Board has had in view in advocating such an appointment, and for furnishing any other information."

The resolution was carried nem. con. and it was decided that the following gentlemen approach the Governor: Mr. Bourne, His Grace the Archbishop, Mr. Campbell and Mr. Barclay.

Cotton—The Secretary submitted report with regard to the Cotton Industry along with letters from Mr. M. H. M. Farquharson of Cornwall Pen, Lacovia. It was decided to circulate these.

Arrowroot—The Chairman read report from the Secretary saying that he had nine barrels of arrowroot at present at the Medical Office, and twenty more coming in, also that he had advised the Superintending Medical Officer that he was prepared to supply the public institutions at once.

School Gardens—A letter was read from the Colonial Secretary's Office acknowledging receipt of letter from the Board with regard to the general establishment of gardens in Elementary Schools.

Resignation of Mr. G. D. Murray—The Chairman read a letter from the Colonial Secretary's Office saying that the Governor had accepted the resignation of Mr. G. D. Murray of his appointment as a member of the Board of Agriculture and of the Sugar Experiment Committee.

Indian Cattle—A letter from the Colonial Secretary's Office was read intimating that the Secretary of State for the Colonies has approved of His Excellency's action in the matter of facilitating the importation of Indian Cattle into Jamaica by means of the coolie immigration vessels if this can be arranged, and of his proposal to continue to further private requests for facilities for the importation of cattle by means of such vessels on the understanding that all such requests for the assistance of the Calcutta Emigration Agency must be made through the Colonial Government.

Reports—The following Reports from the Director of Public Gardens were submitted :—

(a.) Instructors' Reports and Itineraries.

(b.) Report Hope Experiment Station.

The following Reports from the Island Chemist were authorised to be circulated :—

(a.) Distribution of cured yeast.

(b.) Re-opening of Agricultural Course.

The following papers which had been before the Board and circulated for further consideration were now submitted for final consideration :—

(a.) Reports and Itineraries of Instructors. With reference to Mr. Briscoe's report, the Board asked to be informed as to the points in which the packing of oranges at the Trinity Ville Show was defective.

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